THE AMERICAN GAS LIGHT JOURNAL

REDMANAKENNY, N.Y.

PUBLISHING OFFICE No. 32 PINE STREET

DEVOTED TO THE INTERESTS OF ILLUMINATION, HEATING, MECHANICAL, CHEMICAL AND GENERAL SCIENCE.

VOLUME LXXIII.—No. 12. Whole No. 1,319. | NEW YORK, MONDAY, SEPTEMBER 17, 1900. | $3 PER ANNUM, IN ADVANCE.

A. M. CALLENDER & CO., Proprietors. C. E. SANDERSON, Manager. THOMAS J. CUNNINGHAM and ELBERT P. CALLENDER, Editors.

ENTERED AT THE POST OFFICE AT NEW YORK, N. Y., AS SECOND-CLASS MATTER.

CONTENTS.

An Asterisk (*) denotes an illustrated article.

The Galveston Disaster 441

OFFICIAL NOTICE—

Twenty-eighth Annual Meeting, American Gas Light Association 441

Slot Consumption where Meters and Fitting are Supplied—An Opinion on Paying Averages, and One Way of Obtaining Them, by Mr. George Helps 442

*The Design of Steam Power Plants.—No. III.—Continued from Page 371, by Mr. Henry C. Meyer, Jr. 444

Acetylene for Train Lighting 444

Regulation in Long Distance Power Transmission by Electricity, by Mr. F. A. C. Perrine 446

Municipal Home Rule: Its Scope and Limitations, by Mr. R. E. McMath 448

Practical Mathematics 450

Limits of Electric Transmission, by Mr. A. D. Adams 451

Crude Gas Liquor as a Manure 452

ITEMS OF INTEREST FROM VARIOUS LOCALITIES 452

"Gus." Littleton Heard From—Artificial Gas for Conneaut, O.—Mr. G. A. Strain Takes Charge at Bellevue, O.—New Holder for the Consolidated (N. Y.) Company—The Governor of Massachusetts Reappoints Mr. Chas. H. Gifford to the State Board of Gas and Electric Light Commissioners—The Plant of the East Liverpool (O.) Company Completed—Contract for the Western Gas Construction Company—The Peoria (Ills.) Gas Ordinance—Holder for the Watertown (N. Y.) Company—A Budget from "Observer"—Dr. Jas. M. Gray on the Question of Gas Supply—Cheaper Gas for Fall River, Mass.—Mayor Weaver, of Louisville, Vetoes a Gas Ordinance—And Other Items.

The Market for Gas Securities 454

THE GALVESTON DISASTER.—The disaster at Galveston, Texas, takes on vaster proportion as reliable news concerning it comes to hand. The Galveston Gas Company happily lost none of its men, but the works are badly wrecked, the retort houses and four holders having been demolished. For this authentic news we are indebted to Mr. B. E. Cholar, of St. Louis, under date of the 14th inst.

[OFFICIAL NOTICE.]

Twenty-eighth Annual Meeting, American Gas Light Association.

GENERAL ANNOUNCEMENT.

OFFICE OF THE SECRETARY,
NEW YORK, Sept. 13, 1900.

There will be an annual meeting of the American Gas Light Association held at Denver, Col., October 17th to 23d, 1900.

The meeting will be called to order by the President, Mr. George G. Ramsdell, of Philadelphia, Pa., at 10 A.M., on Wednesday, October 17th. The meeting hall will be in the Ordinary of the Brown Palace Hotel. The headquarters will be at the Brown Palace Hotel, Denver, Col.

The most satisfactory quarters are always obtained by writing in advance to the hotel people, and in doing so a reply should be requested, for which a self-addressed, stamped envelope should be enclosed, as misunderstandings may thereby be averted.

The Brown Palace Hotel is conducted on the American and European plans, and rates for rooms will be as follows:

American Plan.—Rooms without bath occupied by one person, from $3 to $5 per day; occupied by two persons, from $6 to $9 per day. Rooms with bath occupied by one person, from $4 to $6 per day; occupied by two persons, from $8 to $10 per day.

European Plan.—Rooms without bath occupied by one person, from $1.50 to $4 per day; occupied by two persons, from $2.50 to $5 per day. Rooms with bath occupied by one person, from $2.50 to $6 per day; occupied by two persons, from $4 to $8 per day.

Other hotels at Denver are the St. James and the Albany, rates at each of which are from $1.50 to $4 per day (American and European plan).

The Roll Call will be made by means of the door card system. Each member upon entering the hall for the first time will at the door receive a special card upon which he will find his name, address, etc., as these appear on the Secretary's books, and such card should be corrected and given to the doorkeeper. Members in attendance should attend to this very carefully, as these cards are used immediately after the meeting for correcting the annual membership list. Visitors will please hand to the doorkeeper their personal cards.

A blank form of application for membership accompanies this circular. More can be obtained of the Secretary. Remember, all applications must be in the Secretary's hands by October 7th, at the very latest, otherwise they will not be acted upon at this meeting.

The list of papers to be read at the meeting is as follows:

"The Use of Cards for Records and Accounts," by Mr. Wm. C. Anderson, Norristown, Pa.

"Inclined Retorts," by Mr. A. H. Barret, Louisville, Ky.

"Gas Advertising," by Mr. C. R. Collins, Seattle, Wash.

"The Uses of Gas for Manufacturing Purposes," by Mr. Jas. H. Walker, Milwaukee, Wis.

"Municipal Control of the Price of Gas," by Mr. Alfred E. Forstall, Montclair, N. J.

If the papers are of a sufficiently high standard the Beal Medal will be awarded to the author of the best paper presented; the question of which is best to be decided by the proper committee.

A lecture will be delivered to the Association, by Dr. E. G. Love, of New York city, upon "The Theory of the Incandescent Gas Light."

In addition to the papers and lecture the report of the Research Committee will deal with the question of the Edgerton Standard referred to the Committee at the last meeting, and with the other subjects that should give rise to a good discussion.

During the days of the meeting all the announcements will be posted on the bulletin boards in the hotel. All members are warned to take notice thereof accordingly.

All members attending the meeting are particularly requested to wear their membership badges in plain sight, thereby greatly aiding the officers and the local committee in their work, by affording a ready means of recognition.

In order that the "Year Book" containing the report of this meeting may be published and issued to the members immediately after the meeting, notice is hereby given that, if any of the speakers at this meeting desire to correct their remarks before they are printed, they will be given an opportunity before leaving Denver, Col., but not after. The stenographer will have typewritten copy of the principal discussions prepared at the headquarters between the sessions of the meeting, and all those who desire to correct their remarks must notify the Secretary at the close of the session at which such remarks are made, as all the

reports will be turned in to the printer immediately after the adjournment of the meeting.

Special rates for transportation have been granted (viz., full fare going and one-third fare returning by the same route), by the several Passenger Associations named and under the conditions noted:

The Trunk Line Passenger Committee, covering territory west of New England and east of Niagara Falls, Buffalo and Salamanca, N. Y.; Pittsburg, Pa.; Bellaire, Ohio; Wheeling, Parkersburg and Charleston, W. Va.

The New England Passenger Association, covering nearly all of the lines in the New England States.

The Central Passenger Association, covering the territory bounded on the east by Pittsburg, Salamanca, Buffalo and Toronto; on the north by the line of and including points on the Grand Trunk Railway from Toronto to Port Huron, thence via Lakes Huron and Michigan to the north line of Cook county, Illinois; on the west by the west line of Cook county and the Illinois and Mississippi rivers, to Cairo, including Burlington, Keokuk, Quincy, Hannibal and St. Louis; and on the south by the Ohio river, including points on either side of that river.

The Southeastern Passenger Association, covering the territory south and west of the Virginias, and south and east of the Ohio and Mississippi rivers.

The Western Passenger Association, covering the territory west of, and not including Chicago, Peoria and St. Louis; in other words, the territory west of that of the Central Association.

[The Secretary here explains at length the conditions necessary to obtain from the Passenger Associations the fare and one-third for the round trip. While the conditions governing this rate for travel are pretty well known, in that they differ in no wise practically from those that ruled heretofore, it is well to keep prominently in mind the fact that the reduction is conditional on there being an attendance at the meeting of not less than 100 persons holding certificates.]

SPECIAL.

As planned at present, the entertainment portion of the programme includes an informal reception at the headquarters—the Brown Palace Hotel—on Thursday evening, and a trip to Colorado Springs and vicinity on Friday and Saturday. This trip is outlined as follows:

Leave Denver Friday morning, reaching Colorado Springs at noon, take lunch at the Alta Vista Hotel, then take carriages for a drive through the Garden of the Gods to Manitou, and up Ute Pass or Engleman's Canon to the Cliff House, where the night will be spent. Music will be provided in the evening and dancing can be arranged for, if desired. The next morning a drive will be taken to Cheyenne Canon and Broadmore, returning to Colorado Springs at noon for lunch at the Alta Vista, and return to Denver in time for the evening trains. The cost of tickets, entitling the holder to hotel accommodations, lunches and seat in carriage for the drives during the trip, will be $5 per ticket. The railroad fare for the round trip between Denver and Colorado Springs will be $2. The total cost of the trip will thus be $7.

Members who have not replied to the letter of August 16th, and indicated their intention in regard to attendance at the meeting, traveling by the special train and participation in the entertainment outlined, will please send in at once, properly filled out, the postal cards sent out with that letter. This is necessary to enable the Committee of Arrangements to proceed with their work.

Be sure to obtain a railroad certificate when buying your ticket for Denver. The greater the number of certificates handed in, the easier it is to get the reduction in rates for future meetings, since the railroad officials count the certificates turned in as marking the full attendance. In our case the number of certificates is from 50 to 100 less than that of the persons in attendance, and our requests for lower rates are not given the consideration they should receive. Could we have shown certificates equal to the full attendance at Niagara Falls and New York we could probably have obtained a rate of one fare plus $2 for the round trip to Denver.

Apply for ticket and certificate at least 30 minutes before train time. Each person must sign his own certificate *at time of purchasing* tickets for Denver, Col. Be sure to hand the Secretary your certificate as soon as you reach the headquarters. Apply for return ticket at least 30 minutes before train time, and have your certificates with you.

All persons, ladies included, attending the meeting are entitled to the reduced rate from the territories named.

Members will please hand their certificates to the Secretary, or his clerk, upon arrival at place of meeting. If there are 100 members present holding certificates each certificate will then be properly endorsed and handed back to the owner before adjournment.

Members having questions which they desire to put into the Question Box should send the same to the Secretary as soon as possible, in order to give him an opportunity to have them printed and distributed to the members before the meeting so as to secure for them careful attention.

Keep this circular in your pocket, and apply to it if you are in doubt.

ALFRED E. FORSTALL, Secretary.

Slot Consumption Where Meters and Fittings, etc., are Supplied.—An Opinion on Paying Averages, and One Way of Obtaining Them.[1]

By MR. GEORGE HELPS, of Nuneaton, England.

The profit of a slot meter business, it is assumed, depends on the following considerations:

1. The capital chargeable to the slot consumption business for works, plant and mains, and the interest to be provided by each slot consumer on such capital.

2. The extra cost of administering each slot account, over and above that necessary with the ordinary consumer.

3. The depreciation reckoned for the wear and tear of the various gas fittings, cookers or fires.

4. The extra amount charged per 1,000 cubic feet to cover the foregoing extras.

5. The cost price of gas delivered at the consumer's meter.

6. The selling price of gas to ordinary consumers.

Capital Chargeable to Slot Consumption Business, Etc.—The amount of the capital of a works chargeable to slot consumption should be in direct proportion to the quantity consumed. Thus, if slot consumers use one-tenth of the gas sold, the interest on one tenth of the capital should be charged to them. The interest each consumer should be expected to provide would obviously be the total divided by the number of consumers.

Administration.—Any one who has had much experience in the slot business, and adopted a system whereby the special charges connected with it are distinguishable from ordinary expenses, and gone carefully into figures, will admit that the extra office expenses are considerable, and will amount to at least 2s. 6d. or 3s. 6d. per consumer per annum, and may even reach considerably more than this.

Depreciation on Fittings, Etc.—The amount of depreciation is generally fixed at one-tenth of the first cost of service, meter and fittings per annum, or 2s. for every pound expended.

Extra Charge for Slot Consumption.—The extra sum charged varies from 5d. to 10d. per 1,000 cubic feet; the average figure being about 8d.

Cost Price of Gas.—The cost price of gas in this connection must, of course, be considered as including all ordinary charges, less the amount received for residuals, coke, tar, liquor or sulphate; but unhampered by any of the special charges for a slot business, as all these must be taken separately.

Selling Price.—The selling price of gas to ordinary consumers (by ordinary consumers is meant all consumers other than slot) it is hoped is now uniform, or nearly so; that differential prices—if not already non-existent—are fast dying out. It is assumed that the only reduction now made to consumers is a small discount based on quantity, and not on the uses to which the gas is put. It is also assumed that the selling price to ordinary consumers is a fair one. It then becomes evident that slot consumers should be charged the same price as ordinary consumers, *plus* the extra expenses they cause.

For supposition, let us take a gas works having a capital of £45,000, on which 7 per cent. dividend is paid—the slot consumption being one-tenth of the whole, and the number of slot consumers 1,000; the extra administration at 2s. 6d. per slot consumer; the cost of fitting up a house at £4; the extra charge to slot consumers at 8d. per 1,000 cubic feet; the cost price of gas at 2s. 6d. per 1,000 cubic feet; and the selling price to ordinary consumers at 3s. 6d. On the lines now laid down, each slot consumer, to pay a minimum profit of (say) 6s. 3d. per annum on the capital employed, must provide per annum—

For interest on the proportion of capital employed— $\frac{\text{one-tenth of 7 per cent. on £45,000}}{1,000} = 6.3\text{s. (say)}$	£0 6 3
For extra administration (say)	0 2 6
For depreciation on cost of service, meter, fittings, etc., 2s. per £1 on £4	0 8 0
For the quantity of gas which must be consumed to realize a profit of 16s. 9d. (the profit per 1,000 cubic feet being 1s. + 8d.) = 1s. 8d. $= \frac{16\text{s. 9d.}}{1\text{s. 8d.}} = \frac{201}{20} = 10{,}050$ cu. ft., at 2s. 6d., the cost price	1 5 1½
10,050 cubic feet, at 4s. 2d	£2 1 10½

The consumption of 10,050 cubic feet should, therefore, be looked upon as the very lowest average allowable; and, of course, at this

1. *Journal of Gas Lighting.*

figure the slot consumer has the advantage over the ordinary consumer of 4 54d. per 1,000 cubic feet. Thus—

Amount received for 10,050 cubic feet from slot consumer.	£2 1 10½
Less extra charges	0 10 6
Leaving for the 10,050 cubic feet	£1 11 4½

Or 37.46d. per 1,000 cubic feet.

The difference per 1,000 cubic feet to be provided by the ordinary consumer being 42d. — 37.46d. = 4.54d. per 1,000 cubic feet.

Now, if slot consumers are to be put on the same basis as ordinary consumers—and surely they should be—it is necessary for the average consumption to be such as will, with the price of gas at 4s. 2d. per 1,000 cubic feet, produce 3s. 6d.—2s. 6d. = 1s. per 1,000 cubic feet profit, in addition to the other charges. Thus—

Wear and tear and extra administration = 10s. 6d.

Therefore, the quantity of gas to be sold at 4s. 2d. to realize 3s. 6d. per 1,000 + 10s. 6d. the profit per 1,000 being 4s. 2d. — 3s. 6d. = 8d. is $\frac{126}{8}$ = 15 759 cubic feet, or, if gas is to be sold to slot consumers on an equitable basis with ordinary consumers, the extra amount charged to the slot consumers must cover the extras for depreciation and administration; and in the case cited, the necessary consumption would be 15,750 cubic feet. The profit obtained from a sale of 15,750 cubic feet will amount to 15,750 at 1s. = 15s. 9d. per consumer. It is thus seen that, with a difference of 8d. per 1,000 cubic feet between slot and ordinary price, for every £1 spent in fitting up a slot house, 2s. has to be produced over the price to ordinary consumers, which calls for a consumption of $\frac{24}{8}$ = 3,000 cubic feet. In addition, 2s. 6d. has to be allowed for on account of administration, calling for a further consumption of $\frac{\text{2s. 6d.}}{8} = \frac{30}{8}$ = 3,750 cubic feet. If it is desired to reduce this average, it should be done by increasing the extra amount charged to slot consumers above that of the ordinary. Thus, if the difference is 1s. 1d. per 1,000 cubic feet, then the necessary average will have to be reduced to 10s. 6d. ÷ 1s. 1d. = $\frac{126}{13}$ = (say) 9,700 cubic feet.

A good many people may urge that the slot consumers should have a preference over the ordinary consumers for the following, among other reasons: (1) The slot consumer is a cash customer. (2) He is to be charged with the service as well as all other fittings, meters and things, which he pays off in ten years. (3) That, being a new business, it should have as much encouragement as possible, without unfairly dealing with ordinary consumers. (4) That a slot consumption is a valuable adjunct to a gas company, and should be welcomed by the ordinary consumers, as it should bring about a greatly increased consumption, which, in its turn, is bound to be a harbinger of a reduction in price all round. (5) That the slot consumer tends to utilize the mains and plant of a gas works at times when otherwise they would be partially idle. (6) That it develops a day consumption all the year round, particularly in the summer months when plenty of slot cookers are in use, and therefore little or no additional capital for mains or gasholders is in use on this account.

The last reason requires qualifying, as it holds good only up to a certain point; for it can be readily imagined, seeing the enormous strides day consumption is making, that, in time, it will perhaps mean that the sectional area of the town mains will be governed by the day requirements, and not the night. Again, if the slot consumer is chiefly a day consumer, he invariably increases the night consumption as well.

Even if all these reasons could be admitted—and most surely they cannot be—the very most that can be allowed by the champion of the slot consumer is that on account of the town mains and holders not having to be increased for slot consumers. This is quite an erroneous notion; but it can be readily seen how it would affect the question of price.

The distributing plant of a works may be taken at about 30 per cent. of the capital; and the holders 10 per cent. So that slot consumers might be charged 40 per cent. less for capital than ordinary consumers. The capital in the present case has been stated at £45,000; so that each slot consumer would have to provide only—

$$\frac{60}{100} \text{ of } \frac{\text{one-tenth of 7 per cent. of £45,000} = \text{3s. 9.3d.}}{1{,}000}$$

as interest on the capital supposed to be employed on his behalf. Or whereas 1s. per 1,000 cubic feet sold to ordinary consumers is sufficient profit to pay the necessary dividends, 60 per cent. of 1s. = 7.1d. would be all that was required for the slot consumers to pay. On this basis the necessary amount of profit per 1,000 cubic feet to be charged to slot consumers could be reckoned as 7.1d. or 4.9d. per 1,000 cubic feet less than ordinary consumers—say 5d. per 1,000 feet less. The price, then, to be charged would be 3s. 6d. — 5d. = 3s. 1d.; and as the slot price has been put at 4s. 2d., this would leave 1s. 1d. per 1,000 cubic feet sold to slot consumers to pay for depreciation and extra charges, and reduce the necessary average, as previously shown, to 9,700 cubic feet, where an expenditure of £4 per house has taken place, and where 2s. 6d. only is allowed for extra administration. It will be well, therefore, if the heads of gas undertakings, who are satisfied with low averages, will now look this matter squarely in the face. The profit to be derived per slot consumer on this basis is 9,700 cubic feet at 7d. per 1,000 feet = (say) 5s. 7.9d. per consumer. So that an undertaking supplying 2,500 consumers would make the *magnificent* (?) profit of 2,500 at 5s. 7.9d. = £707 5s. 10d.; and this after giving the slot consumer an unwarranted advantage in price.

Having dilated on the necessity of keeping the averages of slot consumers up, it will perhaps be as well to consider how this can be done. There are many ways; but that which can be called the system of *minimum averages* has been found to work well. To begin with, it is necessary to know the minimum average consumption required, and to have a distinct understanding with the consumers before their houses are fitted up. The condition should be embodied in the ordinary slot agreement, that the company, in supplying and fixing cooking stoves, fittings, etc., free, reserve to themselves the right to remove all, or part of, such, if the consumer does not consume sufficient gas to cover the wear and tear consequent to the use of the same. Under such conditions, the consumer will be given the option of retaining such fittings by purchase, by payment of an increased price for the gas, payment of hire, or any other method that may find favor.

Unless the slot business is very hopeless, it is clear that there will be several consumers using above the minimum average, as well as a good many below it. It therefore follows that it is not necessary to draw a hard-and-fast line, and say that all consumers below the minimum average must be cut off; because such a proceeding, were it practicable, would put the average consumption higher than that called for. It does not require very deep inquiry to see that such a suggestion would be unworkable. On the other hand, it is quite a simple matter to work on the system of minimum averages. For instance, take a case where there are 1,000 slot consumers using 8 million cubic feet, giving an average of 8,000 cubic feet per consumer, made up somewhat as follows:

200	consumers	under	3,000	cubic feet.
100	"	"	4,000	"
100	"	"	5,000	"
100	"	"	6,000	"
100	"	"	7,000	" and so on.

If the 200 consumers under 3,000 are cut off, the average is brought up at once to 11,170 cubic feet. If it is agreed that the minimum average consumption must be 10,500 cubic feet, there can be no doubt that the 200 consumers at 3,000 cubic feet are an absolute loss; and the sooner they are done away with the better. If 15,000 cubic feet are taken as the necessary average, then the 500 consumers under 6,000 cubic feet would have to come off. Again, if 15,000 cubic feet is the minimum average required, consumers using 6,000 can but be a loss, and are best done away with. There can be no hesitancy in coming to these conclusions. If desired, the consumers can be given the option of purchasing the fittings already referred to. Of course, a system that would necessitate the removal of half the slot consumers to begin with, is likely to be looked on with a deal of misgiving; but surely the sooner a consumer who is a source of annual loss is done away with the better.

When the business is tackled in this way, fresh consumers for the honors of slot consumption are not put on without a proper exercise of discrimination; and after a time it is found that very few meters have to be removed each year to keep up an average which is satisfactory. The system can be worked to any desired degree. By the adoption of some such method as this, it can be seen that the business is kept well in hand. The idea of a penny-in-the-slot gas consumer is very nice in theory; but it would be interesting to know how many corporations or companies would be satisfied with the profits derived from the business, if they really knew what the profits were. The tendency is is to mix the slot and ordinary consumers' business together, so that nobody *shall* know how the respective profits stand. The ordinary consumer thus has to pay for the shortcomings of the slot consumer—a most unfair dealing. The slot business has undoubtedly been a good one for the meter manufacturers; but it has yet to be shown that gas companies

have profited by it to any extent, unless at the expense of the ordinary consumer.

For the supplying of small consumers, the weekly system, including hire purchase of fittings, advocated some years ago by managers, unfortunately now forgotten, has much to recommend it. It is far less costly to the gas company; and its results, when properly worked, are far more satisfactory. There may be some corporations and gas companies who are in the happy position of having paying averages, and where there is no necessity to deal with the matter in such an elaborate way as is here suggested—they may indeed congratulate themselves—but they have yet to be known to the writer.

The Design of Steam Power Plants.—No. III.—Continued from Page 371.

By Mr. Henry C. Meyer, Jr., in *Engineering Record.*

In the chapter in this series of papers which was printed last week, discussing the design of horizontal tubular boilers, boiler settings and boiler specifications, the design of riveted joints was not taken up. The following notes relating to this subject forms an important addition to the previously printed information:

In Tables I, II. and III. there are given proportions of riveted joints recommended by the Hartford Steam Boiler Inspection and Insurance Company, which are published through the courtesy of that corporation. The efficiencies for the different joints, given in the table, are to be substituted in the formula for determining the thickness of shell plates. The dimensions to which the letters in Table III. refer are shown in the figure. Butt joints are far superior to lap joints as there is not the tendency of the plate to crack on a line parallel and near to the rivets. The joints are designed for metal having a tensile strength of from 55,000 to 60,000 pounds, and the efficiency calculations are based upon the latter figure. The shearing strength allowed to the rivet iron per square inch of section in single shear, when used in steel plates, is 38,000 pounds, and a rivet in double shear is considered to be equivalent to 85 per cent additional. Rivet steel is allowed for shearing strength 45,000 pounds per square inch of section. In the calculations for the efficiency the rivet is assumed to fill the hole and the diameter of the rivet hole, not that of the rivet, is therefore used. The efficiency of the girth seams given in the tables need not be considered in determining the thickness of shells of boilers.

Table I.—*Dimensions of Double Riveted Staggered Seams.*

Thickness of Sheet, Inches.	Diameter of Rivets, Inches.	Diameter of Rivet Holes, Inches.	Pitch, Inches.	Lap, Inches.	Distance Between Rows of Rivets, Inches.	Edge of Sheet to Pitch Line, In.	Efficiency.—Weakest Part.
¼	11/16	¾	2⅝	4 3/16	1 5/16	1⅛	0 739
5/16	¾	13/16	2⅞	4⅝	1 7/16	1 1/32	0 717
⅜	⅞	1⅛	3¼	5	2 3/16	1 3/32	0 711
7/16	15/16	1	3 5/16	5 3/16	2⅛	1⅛	0 687
½	1	1 1/16	3 32	5½	2⅜	1 5/32	0 677

Single Riveted Girth Seams, used with above Longitudinal Seams

¼	11/16	¾	2 1/16	2¼	...	...	0 545
5/16	¾	13/16	2⅛	2 7/16	...	. .	0 494
⅜	⅞	1 1/16	2⅝	2 13/32	...	...	0.49
7/16	15/16	1	2 7/16	3	...	...	0 466
½	1	1 1/16	2½	3 3/16	...	...	0.449

Table II.—*Triple Riveted Lap Joint.*

Thickness of Sheet, Inches.	Diameter of Rivets, Inches.	Diameter of Rivet Holes, Inches.	Pitch, Inches.	Lap, Inches.	Distance Between Rows of Rivets, Inches.	Edge of Sheet to Pitch Line, In.	
¼	⅝	11/16	3	6 1/16	2	1 1/32	0.77
5/16	11/16	¾	3⅛	6⅝	2 1/16	1¼	0.76
⅜	¾	13/16	3¼	6 13/32	2 3/16	1 7/32	0 75
7/16	⅞	15/16	3⅜	7 13/32	2⅛	1 13/32	0.75
½	1 1/16	1	3 13/16	8¼	2⅜	1½	0.746

Single Riveted Girth Seams, used with above Longitudinal Seams.

¼	⅝	11/16	2 1/16	2 1/16	...	...	0 456
5/16	11/16	¾	2⅛	2¼	...	...	0.419
⅜	¾	13/16	2¼	2 7/16	...	...	0.412
7/16	⅞	15/16	2⅜	2 13/16	...	...	0.42
½	1 1/16	1	2½	3	...	...	0.398

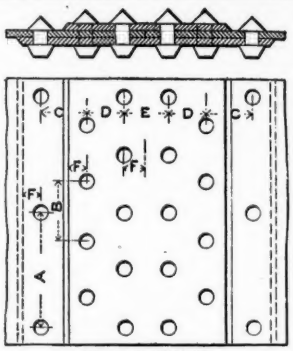


Diagram for Table III.

Table III.—*Triple Riveted Butt Joint with Double Welt.*

Thickness of Sheet, Ins.	Diameter of Rivets, Ins.	Diameter of Rivet Holes, Ins.	Thickness of Strap, Ins.	A.	B.	C.	D.	E.	F.	
5/16	1 1/16	⅞	⅜	6½	3⅛	2⅝	2⅛	2½	1½	0.88
⅜	⅞	1 3/16	5/16	6½	3½	2½	2 3/16	2 5/16	1 7/32	0.875
7/16	⅞	1 5/16	⅜	6¾	3⅝	2⅜	2¼	2 1/16	1 13/32	0.86
½	1 5/16	1	7/16	7⅛	3¾	3	2⅝	3	1½	0.866

Single Riveted Girth Seams Used with above Longitudinal Seams.

Thickness of Sheet, Inches.	Diameter of Rivets, Inches.	Diameter of Rivet Holes, Inches.	Pitch, Inches.	Lap, Inches.	
5/16	1 1/16	⅞	2	2½	0.446
⅜	1	1 1/16	2	2 7/16	0 438
7/16	⅞	15/16	2¼	2 13/16	0.444
½	1 1/16	1	2½	3	0.442

Acetylene for Train Lighting.

In a paper read by Mr. A. Lipschultz, before the Civil Engineers' Society of St. Paul, Minn., on "The Use of Acetylene in Railway Station and Train Lighting," the author said:

Calcium carbide is now made by fusing 100 parts of lime and 70 parts of coke in an electric furnace. The material used for the manufacture of carbide must be of great purity; the lime should contain, on an average, 99 per cent. of CaO, and the coke should not run over 5 per cent. of ashes. The lime and coke are crushed to nut size, then ground to powder in mills, and finally screened. The materials are then weighed and mixed; the latter process is continued for at least five minutes for the sake of uniformity. The mixture is then introduced into the electric furnace and fused under the electric arc. When co'd and broken into pieces, carbide has the appearance of granite, and is equal to it in hardness. A temperature of 2,700° C. is required for its formation. As carbide absorbs moisture from the air very greedily, it must be protected, in transit as well as in storage, from the influence of the atmosphere. It is therefore shipped in air tight packages, and, when kept above ground in a dry place, there is absolutely no danger connected with its storage. Carbide, manufactured as above, is an almost pure product. For manufacturing purposes, one mechanical horse power is required for a yearly output of 1.1 tons of carbide. Carbide is sold at present, in carload lots, at $68 per ton, with strong indications of a reduction in this price as soon as rival capital shall compete in this field.

The most objectionable impurity in carbide is magnesium, which, while melting, takes up nitrogen from the air and forms magnesium nitrate. Such carbide, when in contact with water, gives out a gas rich in ammonia, which, if not washed out of the gas, will clog up gas pipes and burners and produce smoking.

Berthelot first made definitely known the true composition of acetylene as 92.3 carbon and 7.7 hydrogen, with a density of 0.92. If carbide is placed in contact with a small quantity of water it will not generate pure acetylene gas, as the heat developed by its generation will allow the acetylene to polymerize, and the result will be a gas rich in benzine, naphthaline and other polymers, which lower the candle power of the

gas and cause it to vary with each instant, as the lighting, under such circumstances, is done with benzine vapor instead of acetylene gas.

Acetylene is colorless, and when pure and dry it has a special, not entirely disagreeable, smell, as it is neither acrid nor corrosive; when hot and moist, however, the odor changes, as it contains then the products of polymerization.

The temperature of inflammation is about 400° C., and its temperature of combustion about 2,000° C. It therefore has nearly two and one-half times greater heat of combustion than illuminating gas per cubic foot, but for equal amounts of light it gives out very much less heat than illuminating gas. It needs 12½ volumes of air for its complete combustion. The fear of acetylene as a poisonous gas was dispelled several years ago, as it has been conclusively shown by very extensive experiments that its toxic qualities are less than those of coal gas.

There has been an universal belief that this gas attacks metals, and especially copper, and forms with them explosible combinations; and even so learned a man as Professor Lewes mentioned in one of his lectures that, on account of this property, copper must not enter into the construction of an acetylene gas generator, only to declare a few months later, after hearing of the Pintsch Gas Company's experiments, that his position with regard to the use of copper and brass in connection with acetylene gas had been erroneous.

Acetylene gas becomes liquid under about 700 pounds per square inch of pressure at ordinary temperature. At 37° C., which is the critical point for acetylene gas, it requires a pressure of 1,000 pounds per square inch to liquefy it. When this temperature is passed no pressure will convert it into a liquid state.

Acetylene gas, when heated to 1,432° F., will dissociate, and, when not compressed to more than 30 pounds per square inch, the dissociation is confined to the point where the heat is applied, and thus no explosion occurs. When, however, it is subjected to a pressure of more than 30 pounds and heated to the dissociating point, a violent explosion follows, resulting in the destruction of the confining receiver. Acetylene gas not compressed cannot be exploded by shock, heat or concussion. A pipe leading from a gasometer filled with acetylene gas was heated to a white heat about 5 feet from the gasometer, and while local dissociation of the gas at the heated point took place, no explosion could be produced. The shock of a bullet shot through a tank filled with 150 pounds compressed acetylene gas also failed to produce an explosion. The crushing of a receiver, filled with acetylene gas compressed to 150 pounds, under a ram weighing 600 pounds and falling 20 feet, produced neither explosion nor ignition. Acetylene, like every other combustible gas, forms, with air, an explosive mixture, and a room or building containing an acetylene gas generator must be well ventilated, in order to allow for a proper exit of gas leaking from the generator.

As already stated, acetylene has a great density, and a receiver, such as a gas bell, for instance, open on top, will retain gas several days if the gas is not blown out by a current of air. Hence no repairs requiring soldering or heat should be attempted at an acetylene gas generator until all traces of gas have been expelled from the apparatus. Non-observance of the two rules just stated has been the cause of nearly all acetylene gas explosions in practice.

As the carbide commercially manufactured is never chemically pure, it introduces impurities in the gas, of which the principal ones are ammonia, phosphoretted hydrogen and sulphuretted hydrogen. It is due to the two last mentioned impurities that acetylene gas has a disagreeable garlic like smell, which disappears whenever these impurities are removed. With few exceptions, chemical purification of acetylene gas has thus far not been resorted to in this country, for which the following reasons might be briefly stated:

The commercial carbide, as furnished to consumers in the United States, is of greater purity than the similar article in Europe. A second and probably more valid reason is that very few attempts have been made in this country to burn acetylene with mantles as in incandescent gas lighting; in which case it has been found that the organic sulphur and phosphor compounds of the unpurified gas would break down the mantles, thus making a chemical purification of this gas compulsory. Besides washing the gas free of ammonia, which is now done in connection with nearly all modern generators, the elimination of other impurities might be accomplished by three different processes—viz.: (1) passing the gas through chromic acid, (2) the use of bleaching powders and (3) the application of acid copper salts.

A comparison of the different qualities of rays given out by the several light sources is stated as follows:

Coal gas gives out a weak light, with yellow rays; destroys colors, heats the air and has strong toxic qualities. It is weak in diffusive power.

Electric arc light has pale, sickly, violet rays, but is very intense. It is, however, the least diffusive of all lights, and therefore rapidly being supplanted by other and more diffusive lights.

Incandescent electric light has reddish rays, mixed with yellow, and fatiguing to the retina, but gives out little heat.

Incandescent gas light is too often rich in greenish rays.

Acetylene gives pure white rays; does not change colors; is least fatiguing to the retina; has but slight toxic qualities, and, being the most diffusive of all lights known, approaches most nearly sunlight. It has 11 times greater illuminating power than coal gas.

When carbide is placed in contact with water, gas is immediately generated. The different ways in which these two substances may be brought together have given rise to an apparently countless number of generators, all of which, however, may be classified under three different methods of generating this gas—namely:

1. Water drips or flows to the carbide.
2. Water rises to the carbide from below.
2. Carbide is dropped or thrown into a large body of water.

The generators of the first system are mostly used for small experimental and portable apparatus, such as headlights and bicycle lamps. The high temperature of generation incident to bringing a comparatively large quantity of carbide together with a small quantity of water results in the product of a heated, and therefore impure, gas, for which reason such apparatus is unsuitable for any large installation. In another construction of this type of generator water flows through a pipe onto the carbide, which is stored in a receptacle, which in its turn is connected with a gasometer. When gas is generated the bell in the gasometer rises, and when in its highest position closes a valve in the water pipe, thus stopping further generation of gas.

Still another form of generator has a closed carbide receptacle immersed in a tank of water, and a water supply pipe leading from the carbide receptacle into the tank. Water pours in through this pipe and on the carbide until the pressure of the gas rises sufficiently to drive back or hold back the water in the supply pipe. This type of generator has, besides the above mentioned defects, the disadvantage that, in the absence of an especially large gasometer, the generation of gas, after the water supply is cut off, may raise the pressure in the pipes and generator to a dangerous degree. In the generator mentioned, sticking of the water valve or failure of the levers or other means of opening this valve may also result in a dangerous rise of pressure.

Generators of the second system are constructed on the following principle: In a tank filled with water is inserted a bell, free to move up and down on guides. The carbide receptacle is hung inside of the bell, and when the bell is in its lowest position water flows through holes or sieves in the bottom of the carbide receiver. Gas is instantly generated, and its pressure raises the bell, and with it the carbide receiver, thus lifting the carbide supply away from the water and stopping further generation. There are in use numerous modifications of this method, of which one may be mentioned in which the carbide remains stationary, while the water surface is acted upon by the gas pressure, alternately rising to and receding from the carbide, according to the demands of the machine. This entire class of generators is open to the same objection as the class first considered. They also continue to generate gas when water is removed from the carbide.

The third class of generators operates by throwing or dropping a small charge of carbide into a closed tank filled with water. The gas thus generated bubbles through the water, and is led to a gasometer which is large enough to accommodate the amount of gas which the small charge produces.

The charge introduced in the generator falls on a grating, and, being surrounded by a large mass of water on all sides, generation takes place with but little rise in temperature. The gas, by rising in bubbles to the surface of the water, is washed, and contains only traces of ammonia.

With gas produced by this class of generators it is impossible to stop up pipes and burners, as the ammonia and other tar forming ingredients have been washed out of the gas by its upward passage through the water. From such a generator, which has been in active use part of the day, evenings and nights for over two years, we have taken out pipes close to the generator, and also some near the burners, but all that could be found was some white spots like frost, due to lime being carried with the gas from the generator, and nearly all along the pipes the original scale of iron was to be seen; and in the brass pipes of the chandeliers we could find no deposits or signs that the metal had been

affected. Such testimony has been corroborated by other disinterested parties in this country and Europe to such a degree as to make it advisable to consider for use in our plans only apparatus constructed on the third principle—namely, that by which small charges of carbide are introduced by hand or automatically into a large body of water. It is fully realized that a large amount of capital is invested in the manufacture of apparatus of the first and second systems, and the abandonment of these classes of generators will therefore be made unwillingly and slowly; but the future belongs, without doubt, solely to the generators of the third system.

As the charging and cleaning of generators are the only items of expense for labor connected with an acetylene gas installation, it becomes of importance that, with automatic machines, such as are used in smaller installations, a rather large machine be used. For instance, in a plant requiring 50 lights for three hours daily the consumption of gas would be approximately 90 cubic feet per day, necessitating a generator capable of holding 18 pounds of carbide. As there is generally, in a passenger station or freight depot, a man to be found whose duties will permit him to spend an hour in charging and cleaning the machine, it will be seen at once that a generator holding, for instance, 54 pounds of carbide would require attention only about twice a week for a couple of hours, and such attention can be given without seriously interfering with the attendant's other duties. The limit in size for an automatic machine is reached in a generator capable of holding a charge of 100 pounds of carbide. This would supply practically 150 lights for three hours.

When the installation requires more than 200 lights it would appear best to use a machine charged by hand, and employ an attendant for the sole purpose of taking care of the plant. This is by far the safest and most satisfactory way of generating, and there is no doubt that for all larger installations, and also for village and town plants, such a system, with a hand fed generator in connection with a liberally proportioned gas holder and a proper system of piping, will prove more economical and less liable to accidents than an installation with a number of automatic machines.

As before stated, there is at present in the market no generator which delivers a thoroughly dry gas, and it becomes therefore of the utmost importance, in piping for acetylene, to follow out the rule that all pipes must dip from the burner back to the generator, in order to free themselves from moisture and condensation, which otherwise will surely freeze up in the pipes and prevent the gas from reaching the burners.

It is self evident that the generator room must be kept moderately warm all the year round, in order to prevent the water in the generator from freezing. There is no danger from the proximity of a stove or heater. The charging and cleaning of the generator are to be done by daylight, and no artificial light must be permitted in the generator room when the machine is open, as, for instance, in charging.

A burner consuming 1 foot of acetylene gas per hour will yield from 45 to 50-candle power, whereby it will be understood that the piping for acetylene can be of much smaller size than for coal gas. It is, however, not advisable to use a smaller size than ⅜-inch pipe. Common burner cocks, such as are used for ordinary illuminating gas, answer very well.

With reference to burners, is must be stated that good burners are still very expensive. Cheap burners are an everlasting source of trouble, and necessitate constant renewals. The only burner which has been found to work satisfactorily with acetylene gas is constructed on the following principle: The gas, before issuing from the burner, is divided into two tiny streams, so diverted as to form between them an angle of about 90 degrees. These streams impinge on each other, flatten out and form the flame, which is here not in direct contact with the burner, and thus an accumulation of carbon at the burner and a stopping up of the gas hole are prevented. All lava burners are preferable to metallic burners with lava tips, although, if proper care is taken when applying the latter, good service can be had from them also. While we have burners under observatien which, after two years' service, are still in good condition, it is not safe to figure the life of an average burner as more than one year. They should be tested before applying, for capacity as well as for efficiency, as it is not an uncommon occurrence to find in a gross of burners 10 per cent. unfit for use.

Before concluding this part of the paper, given over to a description of the use of acetylene for station lighting, it may be of interest to have some details of a plant in practice. The Great Northern Railway has at Hamline a freight transfer house, which consists of a warehouse about 800 feet in length, having loading platforms at each side for the entire length of the building. The offices are located at one end of the structure. There are altogether about 100 burners, of which 26 are in the office, while the rest of them are grouped in three rows; one row being in the center of the freight house, and the other two rows on the platforms. The generator is installed in a small building about 20 feet distant, which also serves as a dinner room for the men. The office lights burn all night, while the lights in the freight house and platforms are needed for about four hours daily in the winter. The generator is a 100 pound carbide machine, and is charged every other day. The cost per lamp hour (22 candle power) varies from 0.55 cent. to 0.65 cent., according to amount of gas used. This includes attendance, depreciation and renewals. Formerly the lighting was done with kerosene lamps. Aside from the fact that it required the exclusive services of more than one man to fill, trim and clean 100 oil lamps daily, the lights furnished by these lamps was found to be insufficient to do the required work. The light furnished by the acetylene plant has reduced the cost per ton of freight handled, and no other system of lighting could be installed at that place which would rival it in economy.

Regulation in Long Distance Power Transmission by Electricity.

[From a paper read before the Pacific Coast Electric Transmission Association, by MR. F. A. C. PERRINE.]

When we speak of the regulation in an electric plant of any kind, it is common to refer only to the maintenance of the proper voltage at the lamps or the motors of the customers; but in order to obtain a proper regulation for the customer it is necessary in the design of the plant to consider regulation at many different points. In the first place, the periodicity of an alternating current supply, must be maintained constant, which means that the water wheels must have regulators which will maintain a constant speed irrespective of changes in the load and changes in the voltage. In the generators, the regulation is one of voltage, and this must vary with varying load even though the customer may require a voltage as constant as the periodicity. The step up transformers in the generating station are one of the factors which determine the amount of voltage variation which the generator must provide, and in the line we find a disturbing element that must be carefully considered. The final adjustment of the voltage to suit the customer's needs is provided in the sub station where the step down transformers are located.

The regulation of water wheels is effected in a different manner with high and low head wheels. With wheels operating under a low head, large penstocks in which the water moves at a low velocity, are generally available, and, in consequence, regulation of such wheels is always provided by variation of gate opening. This system of regulation, while certainly difficult to accomplish on account of the weight of the moving parts, is ideal in respect to conservation of water, the water allowed to flow being in some respect proportionate to the load. We say "in some respect," on account of the fact that the efficiency of all water wheels falls very materially as the load decreases. This difficulty of efficiency variation produces a difficulty in regulation, for the reason that a certain load change at full load requires a smaller gate variation than the same load change at one quarter load. In order to surmount this difficulty, a recent Italian designer has attempted to close bucket openings instead of gate openings in his wheel, thus operating certain buckets always with full volume of water maintaining full bucket efficiency at all loads.

Such wheels have not been built in this country, although a set has been contracted for by the Montmorency Electric Power Co, at Quebec, where the wheels under this design are now being installed.

The good regulating points of the low head wheels are sacrificed whenever the velocity of flow or the length of the penstocks is increased, and their regulation is correspondingly improved by shortening the penstock, even to its entire obliteration, and operating the wheels in the forebay itself. However obvious this may seem, it is nevertheless the fact that in an Eastern plant recently installed, and not yet in operation, the engineers have led the water from the forebay through 160 feet of entirely unnecessary penstocks laid level.

In a high head plant, the penstock, instead of being short and of large diameter, is long and of comparatively small diameter, with the water velocity rising as high as 12 to 15 feet per second. Here any attempt to regulate the wheels by varying the flow of water produces fluctuations in the pressure which are not only dangerous, but disastrous to regulation. Any attempt to close the gate at the end of a long pipe in which the water is flowing at a high velocity is resisted by the

water within the pipe with a tendency to momentarily maintain the same energy without much reference to the size of the opening. The effect of varying the opening in the water gate is to vary the velocity of the water flowing through it, and, as the energy is equal to one-half the mass times the velocity squared, the variation of velocity tends to maintain at a constant the energy imparted to the wheel in spite of the variations in the mass. In a station operating more than one wheel from the same pipe line, this effect is distributed among all the wheels running. It is often possible by closing one gate partially, to speed up all the wheels for an instant, and the wheels only attain the proper speed due to the reduced opening after they have been subjected to a series of impulses from the surging water within the main pipe. In one case to which the attention of the writer was called, where wheels were operated under about 250 feet head, closing of a single gate at the power house would cause the water to rise in the forebay as much as 10 feet, which rise was accompanied by variations in pressure equal to about 10 per cent. of the full pressure at the power house. Furthermore, it is hardly to be conceived that any throttling nozzle that has been devised can prevent leakage and prevent eddies of water on the back of the bucket, producing disturbances of the speed regulation. In consequence of these facts, it seems to be the clear conclusion that regulation of high head wheels can best be obtained by a system which does not disturb the flow of water in the pipe line, which points either to the deflecting nozzle or the deflecting hood, and while we have no tests of the two systems which are thoroughly reliable, it certainly seems that the undistorted stream from a deflecting nozzle should give higher wheel efficiency at partial loads than will the distorted stream produced by a deflecting hood.

If either of these systems is to be used, the plant should be so installed as to reduce the wastage of water at partial loads as far as possible, since, of course, with a deflecting nozzle or deflecting hood, the flow of water through the nozzle is always constant. Such a subdivision, therefore, of the water wheel units is necessary as will allow cutting out entire wheels when the load shall vary materially. It is not advisable to install such small generating units as this system of regulation seems to entail; but the same result can be obtained by a multiplication of the number of wheels attached to each generating unit. Up to the present time no more than two wheels per generator have been installed in any high head plant, though in certain low head plants as many as five or six wheels have been attached to one generator. Should high head plants be installed with as many wheels as this, the cost of the entire plant could be kept down by increasing the speed of the generators very materially. In fact, for units as large as 1,000 K.W., a speed of from 600 to 1,000 revolutions should be readily attained and the cost of such a plant with five or six wheels on the generator shaft would not be greater than the cost of a plant with one wheel running at about 200 revolutions attached to a generator of the same capacity.

When we pass from the water wheel to the generator we find that while the water wheel must regulate for constant speed, the generator, which is operated at the constant speed of the water wheel, must be adapted for variable voltage regulation. In drawing specifications for generators it is far more common to demand extreme self regulation as regards constant voltage than it is to demand a possibility of great voltage variation, whereas in the generating stations the machine must necessarily be varied in voltage even though a constant voltage be demanded by the customer, and in consequence, machines that are designed for self regulation at constant voltage are not generally satisfactory in long distance transmission plants. This is especially true on account of the fact that it is customary to measure the regulating properties of the generator on a non-inductive load. A non-inductive load in a long distance transmission plant is an impossibility, for even though the plant be used only when furnishing a non-inductive load, as of incandescent lights, the lines and transformers introduce at the generator a reactance which must be taken care of by the design of the machine. Indeed, the extremes of reactance are always encountered in such plants, since at low loads the long lines will make the generator current lead; at high load it may lag very materially. In consequence of these facts, the inductive regulation of the generator as such must be as high as possible, though the ohmic resistance of the machine need not be necessarily low, as would be the case for a close self-regulating machine operated on a non-inductive load; and many generators acceptable in ordinary power stations are unsatisfactory in long distance plants, because they will vary in voltage greatly when inductive loads are applied, and they have not sufficient margin of field capacity to permit of over excitation necessary for overcoming the effect of the lag factor. In consequence, the capacity of both the field and the armature must be higher than is commonly allowed, or else under the common conditions of running, the machines will not be able to use within 10 or 15 per cent. of the full energy delivered by the water wheels.

It is not often acceptable in long distance transmission plants that the generators should have a possible voltage regulation equal to the full amount of the line loss, but they must be designed to permit from two to three times the voltage variation determined by the losses in the lines. It may seem anomalous to state in the beginning that the machines need not be designed for close self-regulation and in the end that their inductive drop must be smaller, but when it is remembered that close self-regulation may be produced by low ohmic resistance, which is unnecessary for small inductive drop, the anomaly is explained.

The same observations are true of the step up transformers. The only essential difference between the transformer effect and the generator effect is that while the regulation of the generator on non inductive load can be about one third the regulation of the transformers on an inductive load, it seems to be impossible to design a generator with more than one-fifth the regulation of the best transformers. Furthermore, as the generator must compensate for the voltage regulation, both within its own coils and also within the coils of the step up and step-down transformers, as well as throughout the whole line, it follows that the transformers should be designed to relieve machines as far as possible of great necessity for variation as the inductive effect of the load changes. In consequence, the specification of the inductive drop through a transformer is, in general, more important than a specification of the non-inductive regulation.

Perhaps the worst disturbing effect of all is to be found in the line itself. Here we have not only an inductive drop, but also a heavy capacity current, the capacity current remaining practically constant at all loads while the inductive drop varies with the load. The question for the proper disposition of the line to have the capacity current from the line counteract entirely the various reactances throughout the circuit, is a very alluring one and has been tried by many designers; but as the capacity current remains constant while the reactance continually varies with the load, it is impossible to so adjust the line in height above the ground and distance between wires as to effect any serviceable self regulation. If self regulation consisted in the maintenance of a constant voltage at a constant load, the line might be so designed as to aid in producing this effect, but as the load falls the importance of the leading current in the line becomes greater, while as the load rises its importance diminishes, in both cases disturbing the voltage and demanding from the machine a wide range of possible manual regulation. Until recently, the exact effect of the line as regards both capacity and inductance, proved to be a difficult problem for solution, though, of course, the solution could be accomplished by several methods on devoting a sufficient amount of time. The line itself limits the amount of power that can be transmitted to a great distance, for the reason that for a line of about 100 miles in length, with voltage between 40,000 and 50,000, from 1,200 to 1,500 kilovolt amperes must be used in charging the line—unless reactance coils are used—and, in consequence an amount of power less than 3,000 HP. cannot be satisfactorily delivered such a distance. Even where the selling price of power is enough to counterbalance the cost of the line of such a length, the large capacity current makes any feasible system of regulation almost an impossibility with a smaller amount of power to be delivered.

By the use of reactance coils at the sub-station, the generator current at no load can be made very small, and I believe it will pay to put in reactance coils on long lines, not only to reduce the generator current and line loss at no load, but as sub station voltage regulators. If half the charging current be neutralized, the lower limit given for the power that may be transmitted over a 100 mile line will be reduced one-half. I believe the proper way to regulate the voltage at the sub station is by the use of adjustable reactance coils and a compensated voltmeter at the generating station. In any case, feeder regulators should be put on the feeder circuits, but no regulators on transformers, especially where two or more banks are operated in parallel.

Finally we come to the regulation within the sub station. A substation must deliver voltages that are constant within short periods, at the very least. The customer may demand a voltage variation on account of the losses within the distribution lines as his load changes, but during such periods as the customer's load remains constant, the voltage must remain constant. The fact that his voltage may change with his load demands some system of manual regulation within the substation, and because the generator will necessarily alter its voltage with

an alteration in the character of the load, irrespective of its size, it is not generally safe to install a sub-station system in which at least 25 per cent. voltage variation is not, in the extreme cases, possible.

To summarize, it is the writer's opinion that the following points are somewhat new and demand careful consideration :

1. The subdivision of water wheels and the use of extremely high speed machinery.

2. A wide range in the possible voltage variation in the generators, with generators and transformers both designed not for good non-inductive load regulation, but for good inductive load regulation.

3. Lines designed for the smallest possible capacity current without reference to any attempt at balancing the line capacity against the load lag.

4. The use of reactance coils at the sub-station (instead of regulator heads on transformers) and wide range of regulators in feeder circuits.

Municipal Home Rule: Its Scope and Limitations.

[A paper read by Mr. Robert E. McMath, President Board of Public Improvements, St. Louis, at the Milwaukee Meeting of the American Society of Municipal Improvements.]

The government of cities is a subject of vast and growing importance. When the United States first took its place among nations the three largest cities—Philadelphia, 42,000; New York, 33,000, and Boston, 19,000—had an aggregate population of less than 100,000. The early State constitutions contained no provisions relating to the government of cities, for there was then no need. As the need became manifest such provisions found place in the later constitutions. Of the mass of legislative acts a great part relate to the affairs of cities, towns and villages, and no small part of the labors of courts are given to endeavors to define the rights, relations and duties of municipal corporations to their inhabitants, to the State and to the persons or corporations having contracts or business relations with municipalities.

A considerable body of literature has been produced devoted to the discussion of municipal problems, which might be studied with profit, but comparatively few municipal officers have opportunity to make such study. The American Society of Municipal Improvements has properly charged one of its standing committees with the duty of making a report on city government and legislation. The objects of this society are practical and the treatment of the assigned topic should be to find what is rather than speculate as to what ought be.

Of the nature and properties of a municipal corporation it has been well said "There is nothing in the law more complex and abstruse," and again, "Our municipalities in their creation and operations stand closely related both to the State and to administrative law. They offer to the statesman, the legislator and to the jurist questions of perplexing intricacy and deepest moment. How thoroughly our municipal institutions are wrought into the framework of our government and administration, how important the functions they are made habitually to perform, how closely in the exercise of their diversified powers and in the discharge of their varied duties, they touch the daily life and affect the most important interests of the citizen and of the property owner cannot fail to impress the most inattentive observer."

The whole system of government in the United States is intended to be one of checks and balances. Limited powers are granted to governmental agencies for specific purposes, and the residue of powers not so delegated is reserved to the people. In accord with this general policy the right of local self-government is expressly asserted as inviolable.

We have a series of governmental agencies: A federal administration to which is committed all matters relating to other nations and such internal affairs as touch all parts of the country alike. Secondarily, but not subordinate in the sense of being subject to dictation as to local policy, comes the State, which has full power over the conduct and interests of the people of the State, but the power is defined and limited by written constitutions. Next we have in most States counties, which are political subdivisions of the State, subordinate to and auxiliary to the State government. Counties are vested with powers to manage certain local affairs, but since counties do not have legislative powers they are little more than local agencies of the State. Next in order comes the municipal corporation (a term which includes cities, towns and villages), whose functions are restricted to a defined territory lying within the State and usually within a county. Some few cities are in some respects counties, or perform duties to the State as if they were counties.

Municipal corporations have their powers and duties defined by constitution, charter or statute, and the construction of these powers and duties is strict. Among the powers is that of establishing, by ordinance or by-laws, local regulations governing the conduct of persons in many matters relating to the municipality, and of punishing those who violate such regulations; of raising revenue by taxation and otherwise to bear expenses of the local administration; of determining the advisability of making local improvements and the manner and extent of the same; of guarding the public health; of caring for sick and helpless persons; and generally to do anything not inconsistent with the constitution or statute of the State or nation that will promote the prosperity, welfare, comfort, convenience and pleasure of the people of the city.

As duties usually cities are required to act as the agent of the State in the maintenance of peace and good order within their bounds, and for these purposes to maintain a police force.

A fundamental principle of the system of government is to bring the details of public business close to the community specially interested so that matters of merely local interest should be locally controlled. This principle is what is known as home rule, as distinguished from control of local affairs by a distant general authority. The American conception of home rule is that each locality shall choose its local officers and manage its purely local affairs without restraint or supervision by a State authority. In some other lands the idea is modified by more or less supervision by a central authority. Whether the unrestrained home rule of the American idea, or the restricted home rule of the foreigner is the better, is a subject of unlimited discussion.

The ideal home rule is very imperfectly realized in American cities, partly because of State interference, partly because courts do not stand consistently upon a sure ground of interpretation as to the scope and limitations of home rule, and partly because the people of our cities tolerate much misgovernment.

Some thinkers and writers lay the evils of corruption and fraud to the substantial citizen who neglects or refuses to perform his public duties. Substantial citizens in one sense of the word are usually directly responsible for corruption, for no one is corrupted unless there is a corrupter who either tempts or submits to improper demands. In fact, the evils which result from the incompetence of officials are as bad and possibly more numerous than those which come from willful dishonesty, but the situation is much aggravated if incompetence and dishonesty exist together. The substantial citizen who is careless, pessimistic or unwilling to give of his time, means and labor for the public good must bear the responsibility for both classes of evil. But how can the substantial citizen be reached and reformed? Consideration of this question is not pertinent to this report.

In England the right of home rule has existed from the earliest date of authentic record. The Norman conquest overthrew the old order and was followed by the feudal system, but under that system a limited species of home rule was exercised. The Norman city charters conferred the right to protection of person and property rather than the right of local self government. Magna Charta restored the old rights. "Let the City of London have all its old liberties and its free customs as well by land as by water. Besides this we will grant that all other cities and boroughs and towns and ports have all their liberties and free customs."

The struggle on the part of cities for more freedom on one hand and on the part of the central power for more control over the cities on the other hand has long existed and continues to the present day. On the continent the question of municipal home rule and governmetal control has been satisfactorily solved. The rights and duties of municipal bodies have been defined in a way that suits continental systems of government. In England much progress has been made toward the adjustment. In America the lines have not as yet been clearly drawn. Court decisions are conflicting. What is held to be law in one State is not accepted in others and early decisions are not followed in later cases before the same court.

It is not within the province of this report to review the many conflicting utterances of courts at various times of the several States. It is enough to say that decisions have been made which range from the extreme view that municipal organizations antedate the formation of States and that they are and should be free from State control in matters affecting their local affairs to the opposite extreme that municipal corporations are created by the State and are subject to the will of the State. The power to create implies the power of destiny, hence the control. The true relations between cities and the State lie between these extremes.

It is generally conceded that the charter of a city or legislative act granting powers are not contracts within the meaning of the constitutional prohibition as to passage of laws impairing the obligations of

contracts. Hence political powers given a municipal corporation for local government are not vested rights as against the State.

Unless there be express provisions in the State constitution to the contrary the legislature has general supervision and control of cities and may enlarge or diminish their corporate powers at will. But there are limits beyond which legislative control may not go. Counties, towns and cities are recognized in constitutions as local agencies as well as agencies of the State. It is generally held that it is not within the power of the legislature to abolish their powers as local agencies and assume such functions to itself or to confer them upon boards, commissions or officers named by the legislature. But the local agency cannot be allowed to have discretionary power to perform or to refuse to perform the duties which the people of the subordinate jurisdiction owe to the State. Assessments must be made, taxes levied and collected, police and the machinery of courts and administration of justice must be maintained. The power necessarily vested in the legislature to exercise control over cities is intended to be used for good and worthy ends, just as the powers of municipal corporations are intended to be so used. The powers may be abused, and in many cases have been abused. If the city abuses its power the legislature may correct, if the legislature goes beyond its proper limits the courts may intervene, but if the legislature goes wrong but keeps within its legal limits the only appeal is to a subsequent legislature.

The legislative control spoken of extends to all the relations which the city bears to the State, but there is a portion of the functions of the city to which legislative control does not extend. It does extend to all things which have their origin and proceed from the act of incorporation, but these things which existed independently of the act of corporation the legislature can not impair or destroy. The United States Supreme Court has held that the municipal corporation is entitled to the constitutional protection "with respect to its private or proprietary rights and interests." The community has local rights and privileges not created by legislative action. The act of incorporation created a legal personality and invests it with certain powers and privileges, some of which affect the State at large and are of the nature of duties owed the State, others relate to local necessities and conveniences and are exercised or not as the local authority may determine. The real purposes of a municipal corporation is to provide for the popular needs and conveniences of a compactly settled community with which the State at large has little or no concern. The duties to the State are laid upon the city as a matter of convenience rather than necessity.

There are many matters which are clearly local and others as clearly relate to the State, but there are still others whose relation is not so clear. Hence there is much confusion as to where home rule of cities should begin and end. A recognized authority says: "The administration of justice, the preservation of the public peace and the like, although confided to local agencies, are essential matters of public concern, while the enforcement of municipal by-laws proper, the establishment of gas works and water works, the construction of sewers and the like are matters which pertain to the municipality as distinguished from the State at large." To these may be added fire protection, garbage removal, street construction, maintenance and cleaning, markets, hospitals, cemeteries, parks, libraries, museums and other provisions for the comfort, instruction and pleasure of citizens.

In the granting of railway franchises to use the streets it is held that the city acts as agent of the State. The same principle applies to telegraph and telephone and other local public service.

The right of cities to choose their local officers is generally established but the manner in which they are to be chosen or elected is subject to legislative power. The legislature may impose a civil service on cities or cities may adopt such a service for themselves.

Regulation of the appointment or election of officers and the exercise of the power of selection of city officials by State functionaries are very distinct matters. The one is legal and proper, the other is an invasion of the rights of the governed. "The nearer the officers are to the people over whom they have control the more easily and readily are reached the evils that result from political corruption and the more speedy and certain the cure." The foundation principle or assumption is that the people of a city or other political unit are intelligent and virtuous enough to be fully capable of self government.

If the people who are most directly affected by bad government fall into careless ways, become indifferent and will not correct evils when the power so to do is in their hands, how may it reasonably be expected that a body of voters or representatives who have no direct interest will be wise and by timely action remedy evils which are merely local? If the community affected will not defend itself at home, or if the decent elements are so discordant as not to work together they will have little influence at the state capital.

Municipal officers are those whose duties are fixed by charter or ordinance and not by statute. Officers who have charge of pavements, sewers, water works, parks and public buildings, perform duties which are strictly local. They are the managers of the city's property, used for the common benefit of citizens. The mayor of a city is not a State officer if he only performs municipal functions, but if, by statute, he is made a member of a police board ex-officio, he, to that extent is a State officer.

The maintenance of a police force sufficient to secure the peace and safety of all within the city's borders, whether residents or sojourners, is a duty to the State. Hence the proposition that the police is a State agency is generally accepted. If it be a State agency the legislature has control and may compel the city to pay the expenses of a police force even if that force is entirely managed by officers named by the State. In a recent instance this power has been exercised as a right to commit a flagrant wrong, and the courts have held that the legislature, being within the limits of its power, no question can be raised, though the action be unwise.

A certain city which politically is controlled by the party which is in the minority in the State had a police department managed by a board appointed by the governor. The number and salaries of the force were subject to local control, but the police board made all appointments. The board asked the city authorities for an increase of the force, which was admitted to be needed. The request was met by a demand that the members of the city legislative body name the men to be appointed. This was done for several years, and so provocation was given. The police board appealed to the legislature and obtained a new police law which gave the police board almost unlimited powers, and at the first step the cost of police service was advanced from about 19 per cent. to 30 per cent. of the city's revenue. The demands of the police board were made an absolute obligation to be satisfied in full before any municipal need can be provided for. As a consequence of the exercise of legislative control the city is impoverished to the extent of total cessation of all new improvements—is even unable to take decent care of existing streets, bridges, sewers and public buildings.

This case is cited because it presents in concrete form a comment on all theoretical discussions of home rule and legislative control. It shows the possibility that local government and legislature may both take a wrong course. No system of government can by checks and balances prevent untold evil if the administration of affairs falls into the hands of reckless partisans, or men who blindly follow a selfish leader, or of men who are corrupt.

Civic virtues must be in active exercise or the community will suffer.

Home rule in American cities is not clearly defined. Constitutional safeguards are evaded and set aside by strained constructions until little is left except that cities are free to manage city properties, water and gas works, sewers, improved streets and in general the things which the city may do without if it chooses. In all other things the city is under the shadow of legislative control.

Respecting the effect of growing legislative interference with city affairs, Prof. Goodnow says: "The continual interference of the legislature in municipal matters is gradually depriving the cities of the United States of almost all local self government so far as the determination of the policy of the city is concerned. In those States where such central interference has been most marked the people of the cities have very largely lost interest in municipal government, and whenever they desire to see some concrete municipal policy adopted their point of attack is the State Legislature rather than any local or municipal organ."

Mr. Seth Low also says: "This interference though often prompted by a desire to relieve a city from pressing evils, has tended very greatly to lessen the sense of responsibility on the part of local officials and upon the part of the communities themselves."

From this study of home rule, its scope and limitations, the only conclusion that can be drawn is that cities may well be relieved from the discharge of duties in which they act as agencies of the State and be limited to the purely local affairs which provide for the needs of a compact population. The field for municipal activities would then be defined, and energies being concentrated upon definite objects would be more effective than they have been or will be if the field is as broad as many have thought home rule should embrace.

This limitation of home rule will help to differentiate the local affairs of cities from the changing policies which logically attend the combination of functions as State agencies with the conduct of local affairs;

will help to emancipate city governments from the domination of National and State political organizations. So long as cities are called on to act as agencies to carry out the will of the State just so long will the political control of cities be striven for by the great political parties and local interests be held subordinate to general politics.

It is a common delusion that our system of government can be understood by a study of the written constitutions of nation and State and of city charters. The real control of governmental action and the shaping of policies has passed into the hands of those who by consent or by usurpation have control of party organizations, which have no place in constitutions or charters and have slight recognition in laws.

To follow the topic further would lead to arguments that would savor of politics and introduce discussions not within the province of the American Society of Municipal Improvements.

Practical Mathematics.

Engineering, in discussing editorially the subject of "Practical Mathematics," remarks:

Everyone knows that out of a dozen schoolboys, many of them, perhaps, excellent in certain departments of work, but one or two will, on the average, show any aptitude for mathematics. The remainder are not by any means congenital idiots, and the after careers of some may prove them to be possessed of conspicuous ability, but, lacking the power of abstract reasoning, they are quite unable to assimilate the mathematical provender furnished them under the system of teaching now in vogue in our schools. The question arises whether this failure to acquire a working acquaintanceship with a very important branch of knowledge is inherent in the subject itself, or is merely a concomitant of the usual methods of teaching. Professor John Perry, who has been conspicuously successful as a teacher of mathematics (for other than examination purposes, be it understood), affirms that the second of these hypotheses is the correct one, and has persuaded the Science and Art Department to include "Practical Mathematics" as a new subject in their syllabus. The elementary paper set on this subject in 1899 lies before us as we write, and it would be almost impossible to conceive of a greater contrast between the questions set here, and those to be found in the usual type of paper on elementary mathematics. The field covered ranges from simple arithmetic up to the calculus, and it is evident that Professor Perry is no believer in the usual plan of treating mathematics as divided up into a series of watertight compartments, so to speak, each of which is entered in turn, and more or less exhausted before the unfortunate victim is permitted to peep into the next. From our own experience we can affirm that the plan of giving beginners a general survey of every branch of mathematics involves no difficulties, while it certainly excites their interest. Could anything be more bewildering than some of the so-called easy proofs of so called propositions, which result from the usual scholastic method? Relations established with the greatest ease by stepping outside of, say, the algebraical department, are otherwise full of difficulties.

It would be a very interesting experiment to place this paper on "Practical Mathematics" before a smart boy trained on the usual lines. Quite one half the questions set would be utterly beyond him, yet all are elementary, and would easily be tackled by him if taught in a different and certainly more entertaining manner. The ordinary examination in mathematics is largely devoted to ascertaining the candidate's knowledge of mere tricks. If he is unlucky, and fails to hit upon the particular dodge needed, he may waste much time. The questions are often chosen so as to be easily solved by certain special artifices, the usefulness of which is, however, entirely dependent on particular relations between the various coefficients involved. Thus, if the solution of a series of simultaneous equations is needed, the coefficients may be chosen so that the method of determinants is readily applicable. In such equations as arise in practical work, such convenient relations are must generally wanting, and the coefficients are awkward numbers. Text book methods are then the very worst possible; the best plan, that involving the least reference to a logarithmic table, being to divide each equation in turn by the coefficient of x and subtract, repeating the operation with the y's and z's.

Such an example well illustrates one of the defects of the ordinary course in elementary mathematics, namely, its divorce from computation, and as a consequence one quite frequently finds a youth well up in mathematical tricks, but an utter failure when it comes to obtaining a correct arithmetical result from the algebraical or trigonometrical expressions that occur in practical work, thus missing the ultimate aim of applied mathematics. Were the importance of computation more generally realized, teachers would find it necessary to introduce their pupils to the use of logarithms and the slide rule at a very early stage.

The usual course is to make a start with Euclid, which is pre eminently a subject for the display of such tricks as those to which we have referred. There is no general method of solving a problem on Euclid's plan of procedure. Each rider depends on a lucky guess, and if one is out of practice a successful plan of attack may take long to find. Take, for example, such a problem as the construction of a triangle, having given the base, the vertical angle and the length of the bisector of this angle. Anyone skilled in practical geometry would solve this in five minutes by means of a piece of tracing paper; but to discover a Euclidian construction, some of which, it is true, are very neat, is more difficult. Many, we know, would effect the solution by algebra in the first place, and afterwards translate their equations into Euclidian phraseology. A thoroughly practiced hand would, no doubt, be able to avoid this surreptitious use of analysis; but the fact remains that Euclid's methods are invariably dependent on artifices special to the particular problem in hand.

Examinations in Euclid illustrate well the way in which examiners insist on establishing distinct lines of demarcation between the different departments of mathematical knowledge. In trigonometrical work no objection is raised to the writing of "a^2" for the square on the side opposite an angle A; but in Euclid such procedure is strictly tabooed. It is possible that this piece of stupidity arises from the fact that almost the whole of the second book is thus transformed into easy algebra, devoid of all difficulty for even the most obtuse. Everyone knows that half the progress of mathematics has arisen from simplifications of nomenclature and of symbolism, thus avoiding complicated and bewildering paraphrases. Yet in Euclidian geometry (one of the most difficult sections of mathematics), the pupil is compelled to use the same circumlocutions as the original compiler did some 2,000 years ago.

A master of any subject has the major portion of his knowledge coordinated under certain generalizations, and in investigating any new point he proceeds from the general to the particular. No one can fail to appreciate the convenience, indeed, the necessity of such generalizations, but, in teaching, the mistake is frequently made of introducing them too soon. Before they can be useful the student must have acquired a practical acquaintance with the subject, the necessary extent of which will vary with the individual. Thus, if Euclid is taught at all, it should be preceded by a course on practical geometry, in which the student may test the correctness of his constructions by actual measurement, and obtain in the meantime very definite ideas as to the nature of surfaces, lines and angles. In algebra the sooner he is started on the solution of equations the better, and having obtained some knowledge of these he will be better able to appreciate the convenience of the transformations and simplifications of mathematical expressions when he is introduced to them. A great deal of the bookwork given in the schools is utterly out of place. Some of the newer algebras in particular are special sinners in this regard, and are overloaded with difficult and really unnecessary abstract reasoning. As already stated, much of this could be avoided by ceasing to treat each section of mathematics as a separate department, having no connection with its neighbor over the way. The binominal theorem, for instance, is a special case of Taylor's theorem, and its proof might well be omitted till some elementary knowledge of the calculus had been acquired, whilst the working out of a few examples numerically would satisfy the average student of the legitimacy of the theorem in the meantime. Were matters treated on these lines there is no reason whatever why a lad of 16 should not have a fair working knowledge of all these departments of mathematics having direct application to engineering and physical work, from arithmetic up to the calculus.

Squared paper can hardly be too generally employed in mathematical teaching. By its use the most complicated equations can be easily solved, many of which would stagger fairly advanced students taught on the ordinary lines. How many of these, for instance, could solve the following equations taken from the 1899 paper in "Practical Mathematics, Elementary Stage:"

$$2x^{31} - 3x - 16 = 0.$$
$$2.42x^3 - 3.15 \log e^x - 20.5 = 0.$$
$$e - e^{-x} + 0.4x - 10 = 0.$$

Each of these equations was, the examiner reports, correctly solved by elementary students in mathematics, trained by Profesor Perry's system. The use of squared paper is, of course, conditional on the early introduction of logarithms and the slide rule into the mathematical course, so as to render the arithmetical work more manageable. The

nature of a logarithm is easily explained, once a student understands how to extract a square root, and indeed he can himself with th this knowledge alone, prepare with ease a table of logarithms correct to four figures which is sufficient for most practical needs, and the difficult exponential theorem may be accordingly dispensed with or deferred to a late date.

The use of a squared paper not only gives the student an insight into the theory of equations which otherwise he would not acquire for years if at all, but also serves to introduce him to co ordinate geometry and the calculus. As matters stand, these are now usually preceded by an utterly useless course on geometrical conics.

Our own experience is that the notion of differentiation is particulary difficult for a beginner to grasp, much more so than that of integration, though the former is much easier to effect analytically. The fact that an integral may be expressed as an area makes its nature easily appreciated, and its adaption to many practical requirements obvious. The representation of a differential as a velocity does, however, go far to provide a concrete conception of its nature, and many recent works have recognized this.

Some may imagine that whilst a course of practical mathematics such as is outlined by Professor Perry may be well adapted for the ninety-and-nine who now lose themselves in the wilderness of abstract mathematical reasoning, it may be less suited to the needs of those exceptions who are capable of successfully threading the paths where their less gifted comrades go astray. It is on these exceptions that we must depend for the advance of mathematical knowledge, and any method of teaching which handicapped them would certainly be a national misfortune. There is, however, reason to believe that even these would benefit by the teaching reform proposed. The capital knowledge of concrete mathematics they would thereby acquire would be an excellent foundation for deeper studies into its philosophy. It must, moreover, be remembered that if the pioneers of the 17th and 18th centuries had gone too deeply into philosophical speculations as the permissibility of certain of their operations, they would have made but little progress. The existence of functions which have no differentials was undreamt of by Newton, Leibnitz and the Bernouillis; yet modern mathematicians tell us that such functions are in the majority, the existence of differential being an exceptional property. This may be true from an abstract point of view, but in practice the precise contrary is the case. Similarly, all modern text books enlarge greatly on the danger of using non-convergent series, but in practical applications of mathematics such series as occur are nearly always convergent, the others being exceptional; and even when they do occur, a little common sense will often enable the computer to obtain reliable numerical results. From his point of view, such discussions as those of Dirichlet on the convergence of Fourier's series and the like, have little interest.

We must not, however, be mistaken. We do not mean to imply that such discussions are useless, but we object solely to their introduction into works intended for any but a few select students. Neither pure nor applied mathematics, as history shows, is likely to make much advance *per se*, and all honor is due to those pioneers who have the capacity to open up new fields of mathematical thought. The trouble is that from their lofty heights they generally fail to grasp the nature of the average man's difficulties. In applying such knowledge as they have rendered available to his ends he is prepared to accept much on trust, and would find it extremely laborious to do anything else. On the other hand, just at those points at which the philosopher would expect him to fall into trouble, he never makes a mistake.

To take a very simple case, the term "foot-pounds" is used by practicians in two entirely different senses. In the one case it denotes a quantity of work, in the other the intensity of a bending or twisting moment, or the like. A mathematician will point out that in the second case there is a suppressed vector implied; and it has been suggested that, to distinguish between the two, the moment should be expressed in "pound-feet," thus reversing the order of the terms, and drawing attention to the fact that it is a vector quantity, and avoiding all danger of confusion. This confusion does not, however, occur in practice. Perhaps it ought to do, if we had all strictly logical minds, but as a matter of fact it does not. Men engaged in engineering computations will use either concept, day in and day out, without mistaking the one for the other. Similarly, the attempt to introduce the poundal into practical engineering has utterly failed.

THE Jury of Award at the Paris Exposition granted the Bristol Company, of Waterbury, Conn., a silver medal for its exhibit of recording electrical instruments. The Company also was awarded Honorary mention for its showing of recording steam and pressure gauges.

Limits of Electric Transmission.

[By MR. ALTON D. ADAMS in *Sci. Am.*]

The electric transmission of power at pressures that render the conducting wires luminous, cause hissing sounds, and produce a certain sensation in the observer at several feet distant, is being ably exploited.

Referring to the subject a recent writer has said: "The most fundamental present question is the limit of practicable voltage." Again it is stated that, referring to experiments with electric transmission at high pressures, "The carrying out of such experiments has a vital interest far beyond the mere utilization of distant water powers. It may, and very possibly will, open up the way for the wholesale transmission and distribution of power from coal." To fairly consider this question, the clear distinction between the long distance transmission of power and its distribution should be held clearly in mind.

It may, for example, be shown that a cheap and distant power is, or can be, transmitted to a center of population and there distributed to consumers at a profit; but this is not the question at issue. The real problem is whether the cheap and distant energy can be delivered at one or more convenient points, in or near the center of population, at a cost per unit that shows a saving over energy there generated from coal.

It is a well known and demonstrated fact that a central electric generating station in or near a town or city can supply power to a great number of small consumers on a sound economic basis for all concerned, because the generating station can develop power from fuel at a much less cost per unit than can the small user. It remains, however, to be proved that energy from a cheap source, 100 or 200 miles distant, can be transmitted to this central station and there used to drive the dynamos for the local service, thus displacing their engines, at a profit. If the transmitted power is to be used in a great manufacturing establishment, the question remains about the same as when it is destined for a distributing plant, since in either case power can be economically developed from coal at the point of delivery.

When a source of cheap fuel invites the transmission of power there developed to great centers of distribution or consumption, the saving in the cost of fuel per unit of energy delivered over that produced at that center is the chief economic reason for the transmission. The real question of electric power transmission, in large units, over great distances, is whether the saving in fuel warrants the investment in line and machinery and their attendant losses. In power production, the cost of fuel is neither the only nor in most cases the largest expense, and a part of the fuel cost is all that can be saved by the electric transmission. The long distance transmission of power is an undertaking that involves a large investment, and it is only fair that when the cost of power generated near the point of use is to be compared with that of the transmitted power, figures should be based on first class results in a local plant conducted on a large scale. Considering two steam plants, one at a long distance, where fuel is cheap, and the other at the center of use or distribution, an equal economy in the weight of fuel consumed per unit of energy develop should be assumed, the cost of fuel in each case per unit of developed energy computed, and the difference found. The price of steam coal that will develop a horse power hour at the engine shaft, in a first class steam plant, on a consumption of 2.5 pounds, is not more than $3 per ton of 2,000 pounds in most cities of the Central and Eastern States.

Allowing 3,000 working hours per year, the cost of coal per horse power per year is $(2.5 \times 3{,}000 \times 3) \div 2{,}000 = \$11.25$. If the steam generating plant is moved to the vicinity of the mine, this same quality of coal can be had at a much lower figure, say $1 per ton, and the fuel cost per brake horse power hour will then be $(2.5 \times 3000 + 1) \div 2{,}000 = \$3.75$. The apparent saving in fuel by this change of location for the generating plant cannot all be realized, because, to deliver one horse power at the point of use or center of distribution, more than this rate of work must be maintained at the shaft of generating engines to make up for transmission losses. To determine these losses, the elements of the electric transmission system must be considered. To take power in the form of mechanical motion at one point and deliver it as mechanical motion at another point a long distance from the first, by electric means, requires at the generating station dynamos and step up transformers; at the receiving station, step down transformers and electric motors; also a line of conductors connecting the two stations.

A good average efficiency under the varying conditions of load for the dynamos and motors is 90 cent. each, and for the transformers 95 per cent. each. The efficiency of the line will vary inversely with the

outlay for conductors, but would seldom be more than 85 per cent. for a very long distance transmission.

These figures give the complete transmission system, from engine shaft to motor shaft, an efficiency of 0.90 × 0.95 × 0.85 × 0.95 × 90 = 0.62. For each horse power delivered at the motor shaft, the engine must, therefore, supply 1 ÷ 0.62 = 1.61 brake horse power, costing for fuel alone $3.75 × $1.61 = $6.03. As the plant located in a large city consumed fuel to a value of $11.25 per brake horse power year, the saving as to fuel by the power transmission is $11.25 — $6.03 = $5.22 per horse power year delivered by the motor. To effect this saving in the cost of fuel, the capacity of the steam plant has been increased 61 per cent. and the entire electrical equipment added. The items of interest, depreciation, and repairs should now be computed for these additional investments. As the idea seems to prevail, in some quarters, that electrical transmission on a grand and general plan will be commercially practical, if only a sufficiently high working voltage can be employed to hold in bounds the weight and cost of line conductors, the cost of connecting wires and supports is entirely omitted from the following estimate, this being more favorable to the long distance electric transmission than any increase in pressure can possibly be. This omission is made with confidence that the necessary investments and losses, aside from the line, are so heavy as to forbid the delivery of electric power, from a great distance, in competition with that from coal at ordinary prices. Counting the brake horse power capacity of the motor at the point of delivery as one, the capacities of the several other elements in the electrical transmission are as follows: Step-down transformer, 1 ÷ 0.90 = 1.11; step-up transformer, 1.11 ÷ (0.98 × 0.85) = 1.38; dynamo 1.38 ÷ 0.95 = 1.45; and engine, 1.45 ÷ 0.90 = 1.61, as found above. The combined capacity of the dynamo and motor in terms of the brake horse power delivered by the latter is, therefore, 1.45 + 1 = 2.45, and the combined capacity of the transformers in the same terms is 1.38 + 1.11 = 2.49, so that 2.45 + 2.49 = 4.94 times the rate of power delivery must be installed in capacity of electrical apparatus. A moderate price for the dynamos and motors installed with necessary attachments is $25 per horse power capacity, and on this basis their cost per brake horse power delivered at the motor shaft is $2.45 × $25 = $61.25. Allowing $10 per horse power capacity of transformers, installed, their total cost per delivered horse power at the motor shaft is $2.49 × $10 = $24.90, making the total investment for electrical equipment, apart from the line, $61.25 + $24.90 = $86.15 per available horse power at the point of use or center of distribution. But the engine at the generating plant is shown above to require a capacity 1.61 times that necessary if it is located where the power is used or distributed to local lines, and the investment in steam plant is, herefore, increased 61 per cent. to make up for losses in the electrical transmission.

A fair price for a first-class steam power plant may be taken at $60 per brake horse power capacity, exclusive of buildings, making the value of 0.61-horse power capacity $0.61 × $60 = $36.60. The total additional investment for machinery equipment in a long distance electric transmission system, over that for a local plant, making no charge for line conductors or buildings, is $86.15 + $36.60 = $122.75 per each horse power delivery capacity at the receiving station. To compensate for this great increase of investment, there is a yearly saving of $5.22 per delivered horse power. Assuming the very low figure of 16 per cent. on the investment, to cover depreciation, repairs, insurance, taxes, and interest, makes the annual charge for these items $122.75 × $0.16 = $19.64 for each horse power delivered at the point of use or distribution. As the amount saved in the value of coal consumed is only $5.22 per delivered horse power, the yearly outlay of 19.64 is nearly four times the saving.

This comparison is very favorable to the transmission system, because no charge is made for the additional buildings necessary with it or for the line. It should also be noted that, while the labor of operation for the generating and receiving stations and the care of the line will no doubt require more expense than the labor of operation in a steam plant at the place of use, no charge has been made for this increase. As the total cost per brake horse power in a first-class steam plant, using a fair grade of steam coal at $3 per ton, about its cost in many cities, was found to be only $11.25 per year, the extra expense resulting from the equipment for long distance transmission from free fuel is $19.64 — $11.25 = $8.39 per delivered horse power per year. That is, if absolutely free fuel could be had at a point 100 miles from some of our great cities, the electric transmission of steam generated power from this fuel to the cities would involve a yearly loss per delivered horse power of more than $8.39. So much for long distance transmission from the coal mines to great cities.

Crude Gas Liquor as a Manure.

The *Gas World* says that, in a paper by M. Couture before the Agriculturists' Society of France, the author gave an account of recent experiments on the use of crude gas liquor as a manure, these experiments having been carried out by M. Müntz.

The crude liquor experimented on contained from 2.68 to 13.95 per cent. of total nitrogen; and of this from 1.07 to 6.58 appeared as ammonia, 0.72 to 2.23 as sulphocyanides and cyanides, and 1.01 to 5.15 per cent. in an organic form. The experiments were made on light soil, clay soil and siliceous clay soil, on experimental farms belonging to the French government. On applying 1 cwt. total nitogen per hectare (=2.47 acres) to wheat, oats, and grass in vegetation, the result was very bad, the plants being poisoned by the cyanides and the sulphocyanides, even when the liquid was dilute.

Therefore crude liquor should never be applied to growing crops. When it was applied to the soil, however, in the absence of vegetation, the results were different. When, for example, the liquor was applied to the land on 1st November—1 cwt. total nitrogen per 2.47 acres—and barley was sown on 1st December there was no poisoning effect, and the result was as good as in an equal area treated with sulphate of ammonia, 1 cwt. nitrogen to the 2.47 acres, although the sulphocyanic acid amounted to 2.55 and 4.96 per cent. in the lots of liquor employed. When liquor was applied in December and oats sown in spring, the growth was much more rapid and vigorous than under an equivalent amount of sulphate. The weeds had completely disappeared, while they were abundant in the ammonia sulphate patch. Potatoes and beet-root were put in in April and May, the liquor having been applied in February; in October the crop was in some places equal to, in others better than, the sulphate crop. The conclusions are:

1. Crude liquor cannot be used for growing crops.
2. Crude liquor applied a month or six weeks beforehand, so as to enable the unstable poisonous compounds to become oxidised, is a most useful manure.
3. Calcareous or sandy soils and sandy loams if they contain lime are the best for this treatment, not heavy land.

In the department of the Aisne there is already considerable use made of crude gas liquor, at the price of $6 per cwt. of total nitrogen, a figure which stands below the cost of sulphate or of nitrate; and in that department it is used almost exclusively for sugar beet-root—2 cwts. total nitrogen per 2.47 acres, applied in the late autumn and scratched into the soil, which is ploughed in the winter. The beet root growers are well satisfied, as their land is kept very clean and free from disease and insects. Small gas works find their advantage in this; but the liquor varies so much that it has to be sold as per total nitrogen.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

We are in receipt of a line or two from "Gus." Littleton, dated Llandudno, Wales, August 31st, by means of which that good one of the Craft says he is growing tired of tramping about on the other side of the water, and that he expects to be homeward bound some time the coming November. He sends his regards to all, and is ready primed to tell us later on something concerning his impressions respecting small gas works that he looked over during his journeyings.

On August 24th manufactured gas was turned into the mains of the Conneaut (O.) Gas Light and Fuel Company, to the entire exclusion of the natural gas supplied for a term of years. The Company's customers are satisfied with the changed conditions. Its affairs are in the control of Mr. Isaac C. Baxter and his associates; Mr. John McMillan, formerly of Bellevue, O., being the Company's Manager.

Mr. Gray A. Strin has been appointed Superintendent of the Bellevue (O.) Gas Company.

The Consolidated Gas Company, of this city, will erect a large storage holder on the east side of West End avenue, between 65th and 66th streets. It will have a diameter of 187 feet.

The Governor of Massachusetts has named Mr. Charles H. Gifford, of New Bedford, to succeed himself as a member of the State Board of Gas and Electric Light Commissioners.

The City Council of Jefferson City, Mo., has decreed that a special election shall be held there to-morrow, for the purpose of determining

whether or not a bond issue of $25,000 shall be made, the proceeds of the issue to be devoted to the construction of an electric lighting plant to be operated on municipal account.

THE capital stock of the Standard Gas Lamp Company, of Chicago, has been increased to $30,000.

THE new plant of the East Liverpool (O.) Company has been accepted. It is of a magnitude sufficient to supply the gas needs of the city for years to come.

THE Western Gas Construction Company is under contract to erect a complete coal gas works system for the proprietors of the new Company at Charleston, Ills. The Western Gas Construction Company's improved system of condensation and purification is to be installed at Charleston.

MAYOR LYNCH, of Peoria, Ills., has signed the ordinance passed by the City Council which directs that the maximum price for gas in that city for any purpose shall not exceed 75 cents per 1,000 cubic feet.

THE executive management of the Charleston (Ills) Gas Company is as follows: President, D. Turnbolt; Vice-President, C. L Lee; Secretary and Treasurer, W. F. Johnson.

MESSRS. DEILY & FOWLER, of Philadelphia, are under contract to build a storage holder for the Watertown (N.Y) Gas Light Company. It is to have a capacity of 100,000 cubic feet.

THE Bergen County (N. J.) Gas and Electric Company is thoroughly piping for gas the streets of the Borough of Ridgefield.

"OBSERVER," writing under date of the 11th inst., says:

Governor Crane has reappointed Mr. Charles H. Gifford as member of the Board of Gas and Electric Light Commissioners. The Chairman of the Commission, Mr. Forrest E. Barker, has returned from his trip abroad, and the sessions of the Commissioners were reopened Tuesday September 11th, with a hearing upon the petition of the Taunton Gas Light Company for approval of an issue of $80,000 new stock and $100,000 bonds, the proceeds to go to the rebuilding of the Company's works at Weir Junction.

The Northampton Company also has applied for permission to issue $25,000 of new stock for enlargements.

Mr. Charles H. Stone has been appointed Assistant Inspector of Meters. This department was seriously handicapped last year by lack of help or funds to hire assistants. It is hoped the new law, which is now liberal, will improve matters. At one time it was impossible to get meters tested.

Too much cannot be said in commendation of the quiet but efficient work of the Massachusetts Association of Gas Companies. More measures adversely affecting the gas interests of Massachusetts were never brought before a legislature in one session. Most of them needed but clear explanation to the members of the legislature to insure their defeat That this was done is shown by the record, none of them having passed. The annual meeting of the Association will be held this month.

MR. H. L. MCKEE, President of the Meridian (Miss.) Gas Light Company, reports most satisfactory gains in output. Next year quite a sum will be expended at Meridian on plant betterments.

A SEVERE explosion occurred on the works of the Shippensburg (Pa.) Company the afternoon of the 9th inst. The happening was traced to the carelessness of a laboring man named Davis, who was working in the purifying room. Unfortunately he paid the penalty of his life for the sake of a smoke.

DR. JAMES M. GRAY, of Boston, Mass., while sojourning in Chicago was invited by the directors of the Chicago Avenue Church, to address their congregation. He accepted the invitation, and the harangue was delivered Sunday morning, September 9th. Its title was "The Relation of the Christian Church to Civil Government," and some chapters and verses thereof were devoted to the sale of gas. In that relation a part of his speech was this: "The people of Glasgow get 1,000 feet of gas for 50 cents. How do they do it? The gas plant is owned by the municipality and operated on public account. The Board of Aldermen in control contains no boodlers. It would be of little use to turn over gas plants, our street railways, our telephone lines to such boards as we now have. Who is it that keeps honest men on the board at Glasgow? It is the Christian Church." Why the Christian Church should have anything to do with politics, either in Glasgow or Chicago, is beyond us; but if Dr. Gray wishes to reform gas practice anywhere by injecting into it the spirit of religion, we would suggest that about as good a center to begin the good work in as any might be his own home spot—Boston. Mature consideration, though, seems to indicate that Dr. Gray and all others of his class and calling would better honor their profession by sticking to religion, leaving the gas men as business men to work out their own salvation.

THE Cincinnati Gas Light and Coke Company proposes to pipe the outlying village of Evanston.

A CORRESPONDENT in Fall River, Mass., writing under date of the 10th inst., says: "The Fall River Gas Works Company announced last Friday that a reduction in the selling rate will go into effect October 1st. The gross price will be put at $1.25 per 1,000 cubic feet. Users of 5,000 cubic feet and under who pay monthly bills will be granted a discount of 10 cents per 1,000 for prompt payment—within 15 days. Users of over 5,000 feet per month will be entitled to a discount of 15 cents per 1,000, for prompt payment. The ruling rate is $1.40 per 1,000, gross, with a rebate of 15 cents per 1,000.

THE following is the text of the ordinance, passed by the authorities of Peoria, Ills., for the regulation of the gas rate in that city:

Section 1. That the maximum price of gas furnished the city of Peoria, and the citizens thereof, and all consumers of gas therein, shall not exceed the sum of 75 cents per 1,000 cubic feet; such gas so furnished to afford a light of not less than 18 candle power, to be measured and ascertained at the place of consumption, in said city, by the most modern appliances known to science for measuring the candle power of illuminating gas; and the Peoria Gas Light and Coke Company, and the Peoria Gas and Electric Company, and any other company, corporation, person or persons who are now or may hereafter furnish gas to consumers in the city of Peoria, are hereby authorized and empowered to charge all consumers of gas in said city a sum not in excess of 75 cents per 1,000 cubic feet.

Sec. 2. That any company, corporation, person or persons who shall in violation of the provisions of the preceding section charge or require the city of Peoria, or any citizens thereof, or any consumer of gas therein, to pay for gas furnished to it or them, or either of them, a sum in excess of 75 cents per 1,000 cubic feet, or who shall furnish to said city of Peoria, or any citizen thereof, gas less than 18 candle power, shall be subject to a penalty of not less than $25 nor more than $200 for each and every offense.

Sec. 3. That any company, corporation, person or persons who shall remove any meter or meters from the house, store, factory or premises of any consumer of gas in the city of Peoria, against the will and consent of any such consumer of gas who is willing to pay for gas furnished him, it or them by any company, corporation, person or persons, the price established and fixed in Section 1 of this ordinance shall be subject to a penalty of not less than $25 nor more than $200 for each and every offense. Provided, however, that any company, corporation, person or persons furnishing gas to consumers in the city of Peoria, shall have the right to remove any meter or meters for the purpose of repairing the same, on condition that such meter or meters so removed shall be replaced or a new one substituted in its place within 24 hours of the time of the removal of any such meter or meters.

THE following is a reprint of the veto, by Mayor Weaver, of Louisville, Ky., of the ordinance regarding the granting of certain privileges connected with the gas supply of that city:

"To the General Council of the City of Louisville—Gentlemen: I respectfully return herewith, without my approval, 'an ordinance providing for the sale of a franchise, or the privilege of furnishing natural and artificial fuel gas in the city of Louisville,' read and passed by the Board of Councilmen, June 14, 1900, and read and passed by the Board of Aldermen, August 28, 1900.

"The city of Louisville owns stock in the Louisville Gas Company to the amount of $925,000, or one fourth of the capital stock of that corporation, from which stock a dividend of $46,000 is annually divided, which revenue is applied to the discharge of the city's debt for public lighting.

"On the subject of the city's ownership of stock in the Louisville Gas Company, I am of the opinion, as previously avowed, that the city of Louisville should own all of the stock or none, and I shall continue to advise that steps be taken to secure the needed legislation in that direction one way or the other. But owning stock as we now do, it is the duty of the Mayor and the General Council, as the sworn representatives of the people, to be alert at all times to protect such interests. Manifestly, the ultimate effect of the ordinance before me for consideration could be to reduce the city's revenue from this source, and impair the value of the investment.

"My second objection is predicated upon the fact that no upset price is named for the franchise. Investigation leads me to the conclusion that such a franchise to be continued for a period of 20 years is worth to the purchaser $100,000, or 5 per cent. of the gross receipts. Yet not one word of stipulation is set forth in the ordinance as to what price is to be paid to the city. Under existing conditions there could be but one bidder, should such a franchise be offered at auction, namely, the Kentucky Heating Company, which, as is well known, enjoys a monopoly of all the natural gas fields accessible to Louisville. Hence you will see that without an upset price named as a condition of the contract, the amount of the bid would remain entirely with that Company. In my judgment there is no reason or excuse for giving away such a franchise.

"By Section 5 (which has been interlined in every important particular) it is provided that the purchase of the franchise shall at the end of the first year thereafter possess at least 15 miles of underground pipes in the city of Louisville; 20 miles at the end of the second year; 25 miles at the end of the third year; 30 miles at the end of the fourth year, and 35 miles at the end of the fifth year. There is no provision directing where these pipes shall be laid, and no requirement that more than 35 miles of pipes shall be laid.

"This section is unsatisfactory because the pipe mileage is too limited. As before indicated there is nothing to compel the purchaser to extend its line to new consumers so that all our people might participate in the results. It is obvious that the territory selected would be in the thickly populated and wealthy districts, thus leaving the poorer, outlying and residential portions of the city, about 75 per cent. of the entire area, and population, without opportunity to take the service. The Kentucky Heating Company, the only possible purchaser, now having 20 miles of pipes, would be required to lay but 15 miles additional in the five years' time:

"Since it is asserted that the ordinance is in the interest of competition, it is necessary to a thorough understanding of the situation to state that the Louisville Gas Company at present owns and controls 155 miles of mains, and supplies its product to the whole city of Louisville. Therefore, the fallacy of competition so far as this ordinance with its limit of 35 miles of pipe, confined to the central district, is concerned, becomes immediately apparent.

"Another objection is that the ordinance is ambiguous. Section 2, considered with the attached amendment, is very indefinite, if not meaningless. If this be a fuel gas ordinance, that fact should be stated in terms so plain no doubt could arise as to its meaning and effect, and with provisions so emphatic and explicit as to escape all possible liability to damage against the city for infringement of an exclusive right to vend gas for illuminating purposes. And here I do not hesitate to say that I would readily sign a legally drawn fuel gas ordinance, in conformity with the decisions of court, provided adequate compensation were made to the city for the franchise and the privilege of tearing up and occupying the street, and provided, further, that the extension of mains included the smaller classes of consumers, as well as the business districts, whereby general competition would be afforded.

"A still further objection is that no provision is made for a gas inspector, without whose services it would be impossible to fully determine whether the agreement on the part of the purchaser was being complied with.

"For these numerous objections I believe it to be to the best interests of the city of Louisville to return the ordinance herewith and respectfully ask that your action in passing the same be reconsidered."

The Market for Gas Securities.

The story of all August and the current part of September, respecting the city gas share market, must be here repeated. Dealings are few—of course, there are not so many companies now as was the case a year ago—and fluctuations have been within small or limited boundaries, still one cannot fail to be impressed with the strength of a Company which, having considerably more than doubled its capital stock within a year, finds that the double is worth in actual value what the single was. Predicting, however, just now would be a poor game, so it is safe to wait until the new issue of stock in Consolidated is paid for. Less than a fortnight will settle that. The nominal quotation to-day (Friday) for Consolidated was 171½ to 172½. There was some inquiry for Standard common, quite a lot of which is still on "the outside." New Amsterdam 5's are in good request by conservative buyers.

The general gas share market is steady. Peoples, of Chicago, is rather weak, but investors generally seem to have the notion that the rate war there is not of the sort which took New York by the ears in 1899. Peoples is a purchase; Bay State seems to have permanently retired into various "strong" boxes, and Baltimore Consolidated beyond a doubt reflects the strength that lies in the suaveness of its new President, the Hon. Mr. Latrobe.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 Wall Street, New York City.

Sept. 17.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated—Ex rights	$4,595,200	100	171¼	172¼
Central Union, Bonds, 5's.	3,000,000	1,000	106	107½
Equitable Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,800,000	1,000	120	..
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	297	305
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	.	..	.
New Amsterdam Gas Co.				
Bonds, 5's	11,000,000	1,000	105¾	106¼
Northern Union, Bonds, 5's.	1,250,000	1,000	102	103
New York and East River				
Bonds 1st 5's	3,500,000	1,000	103	106⅜
" 1st Con. 5's	1,500,000		115	..
Richmond Co., S. I.	848,650	50	70	..
" Bonds	100,000	1,000	..	.
Standard	5,000,000	100	121	125
Preferred	5,000,000	100	141	145
Bonds, 1st Mortgage, 5's	1,500,000	1,000	116	114
Yonkers	299,620	500	130	
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	165	172
" " Bonds (5's)	15 000,000	1,000	116	119
Bay State	50,000,000	50	1	1¼
" Income Bonds	2,000,000	1,000		75
Binghamton Gas Works	450,000	100	23¾	30
" 1st Mtg. 5's	475,000	1,000	96½	99¼
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	4	4¼
" " Bonds, 5's	5,250,000	1,000	64	67
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Central San Francisco	2,000,000	..	106	108
Chicago Gas Co. Guaranteed Gold Bonds	7,850,000	1,000	104	104¼
Cincinnati G. & C. Co.	8,500,000	100	199¼	201
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,207,000	1,000	106	107
Columbus (O.) Gas Lt. & Heating Co	1,682,750	100	60	65
Preferred	3,026,500	100	84	86
Consumers. Jersey City Bonds	600,000	1,000	102	105
Consumers, Toronto	1,700,000	50	230	235
Consolidated, Baltimore	11,000,000	100	56	57
Mortgage, 6's	3,600,000	..	..	118
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N. J.	1,000,000	100	12½	15
" Con. Mtg. 5's	380,000	1,000	82	86
Consolidated G. & E. Co.'s, Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co.	4,560,000	50	95	97
" Prior Lien 5's	4,598,000	1,000	99¼	100
Detroit Gas Co., 5's	386,000	1,000	100	102
" Inc. 5's	16,000	100	94	94½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	35	40
Fort Wayne	2,000,000	..	35	41
" Bonds	2,000,000	..	60	64
Grand Rapids Gas Lt. Co.	1,000,000	50	..	..
" 1st Mtg. 5's	1,125,000	1,000	..	..
Hartford	750,000	25	..	280
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	101	103
Indianapolis	2,000,000	..	70	80
" Bonds, 6's	2 650,000	..	98	100
Jackson Gas Co.	250,000	50	70	75
" 1st Mtg. 5's	250,000	1,000	101	102½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,822,000	1,000	101½	103
Laclede, St. Louis	7,500,000	100	73	73½
Preferred	2,500,000	100	98	100
Bonds	10,000,000	1,000	110	110½
Lafayette Gas Co., Ind.	1,000,000	100	35	40
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	110	120
Madison Gas & Elec. Co.	400,000	100	70	75
" 1st Mtg. 6's	350,000	1,000	102½	108
Montreal, Canada	2,000,000	100	183	184½
Newark, N. J., Con. Gas Co	6,000,000	..	..	55
Bonds, 6's	4,600,000	.	..	103
New Haven	1,000,000	25	280	300
Nashville Gas Lt. Co.	1,000,000	50	110	..
Oakland, Cal.	2,000,000	..	46	47
" Bonds	750,000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	90¼	90⅜
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	90¾	91
2d "	2,500,000	1,000	104	105
Rochester Gas & Elec. Co.	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	47¼	47½
St. Paul Gas Light Co.	1,500,000	100	48	52
1st Mortgage 6's	650,000	1,000	82	85
Extension, 6's	600,000	1,000	..	..
General Mortgage, 5's	2,428,000	1,000	88	90½
St. Joseph Gas Co.	1,000,000	100	30	34
" 1st Mtg. 5's	750,000	1,000	96¼	98

Syracuse, N. Y.	1,750,000	100			15
Bonds	1,612 000	1,000	88¾	93	
Washington, D. C	2,600,000	20	270	271	
First mortgage 6's	600,000	..	..	..	
Western, Milwaukee	4,000,000	100	93¼	94	
Bonds, 5's	3,830,500	.	107	107½	
Wilmington, Del.	600,000	50	200	210	

Advertisers' Index.

GAS ENGINEERS.

Page

Wm. Henry White, New York City ... 475
Fred. Bredel, Milwaukee, Wis ... 462
Geo. R. Rowland, New York City ... 473
The Western Gas Construction Co., Fort Wayne, Ind ... 440
Humphreys & Glasgow, New York City ... 473
American Gas Co., Phila., Pa ... 462
David Leavitt Hough, New York City ... 472
Economical Gas Apparatus Construct'n Co., Toronto, Ont. 459
Baxter & Young, Detroit, Mich ... 472
United Gas Improvement Co., Phila., Pa ... 467
James T. Lynn, Detroit, Mich ... 472
A. E. Boardman, Brevard, N. C ... 472

GAS WORKS APPARATUS AND CONSTRUCTION.

Continental Iron Works, Brooklyn, N. Y ... 474
Deily & Fowler, Phila., Pa ... 476
Kerr Murray Mfg. Co., Fort Wayne, Ind ... 472
Stacey Mfg. Co., Cincinnati, Ohio ... 475
Bartlett, Hayward & Co., Baltimore, Md ... 473
Davis and Farnum Mfg. Co., Waltham, Mass ... 472
R. D. Wood & Co., Phila., Pa ... 474
Isbell-Porter Company, New York City ... 474
Fred. Bredel, Milwaukee, Wis ... 462
United Gas Improvement Co., Phila., Pa ... 467
National Gas and Water Co., Chicago, Ills ... 469
Economical Gas Apparatus Construct'n Co., Toronto, Ont. 459
The Western Gas Construction Co., Fort Wayne, Ind ... 440
Humphreys & Glasgow, New York City ... 473
American Gas Co., Phila., Pa ... 462
Logan Iron Works, Brooklyn, N. Y ... 476
Riter-Conley Mfg. Co., Pittsburgh, Pa ... 475
Baxter & Young, Detroit, Mich ... 472
American Bridge Co., New York City ... 458
G. Shepard Page's Sons, New York City ... 472
James T. Lynn, Detroit, Mich ... 472
A. E. Boardman, Brevard, N. C ... 472
Sutherland Construction & Improvement Co., N. Y. City 459
Chris. Cunningham & Son, Brooklyn, N.Y ... 464

PROCESSES.

Bartlett, Hayward & Co., Baltimore, Md ... 473
United Gas Improvement Co., Phila., Pa ... 467
Burdett Loomis, Hartford, Conn ... 474
National Gas and Water Co., Chicago, Ills ... 469
Economical Gas Apparatus Construct'n Co., Toronto, Ont. 459
The Western Gas Construction Co., Fort Wayne, Ind ... 440
Humphreys & Glasgow, New York City ... 473
Sutherland Construction & Improvement Co., N. Y. City 459
B. E. Chollar, St. Louis, Mo ... 458

SCRUBBERS AND CONDENSERS.

R. D. Wood & Co., Phila., Pa ... 474
Continental Iron Works, Brooklyn, N. Y ... 474
Logan Iron Works, Brooklyn, N. Y ... 476
Riter-Conley Mfg. Co., Pittsburgh, Pa ... 475

TAR AND CARBONIC ACID EXTRACTOR.

R. D. Wood & Co., Phila., Pa ... 474

AMMONIA CONCENTRATORS.

Michigan Ammonia Works, Detroit, Mich ... 466
American Gas Company, Phila., Pa ... 462

GAS METERS.

John J. Griffin & Co., Phila., Pa ... 480
American Meter Co., New York and Philadelphia ... 479
Helme & McIlhenny, Phila., Pa ... 479
D. McDonald & Co., Albany, N.Y ... 477
Nathaniel Tufts Meter Co., Boston, Mass ... 478
Maryland Meter and Mfg. Co., Baltimore, Md ... 478
Metric Metal Co., Erie, Pa ... 479
Keystone Meter Co., Royersford, Pa ... 478
Detroit Meter Company, Detroit, Mich ... 480

PREPAYMENT METERS.

American Meter Co., New York and Philadelphia ... 479
John J. Griffin & Co., Phila., Pa ... 480
D. McDonald & Co., Albany, N. Y ... 477
Helme & McIlhenny, Phila., Pa ... 479
Nathaniel Tufts Meter Co., Boston, Mass ... 478

GAS AND WATER PIPES.

M. J. Drummond & Co., New York City ... 464
R. D. Wood & Co., Phila., Pa ... 474
Warren Foundry and Machine Co., New York City ... 464
Donaldson Iron Co., Emaus, Pa ... 464
Chris. Cunningham & Son, Brooklyn, N.Y ... 464
Cornell & Underhill, New York City ... 464
Charles Millar & Son Co., Utica, N. Y ... 464

GAS MAIN STOPPERS.

Safety Gas Main Stopper Co., N. Y. City ... 461

GAS TAPPING MACHINES.

George Light, Dayton, O ... 457
H. Mueller Manufacturing Company, Decatur, Ills ... 457

FLEXIBLE JOINTS.

Campbell Mfg. Co., Stamford, Conn ... 415

STEAM BLOWER FOR BURNING BREEZE.

H. E. Parson, Brooklyn, N. Y ... 469

GAS COALS.

Penn Gas Coal ... 471
Perkins & Co., New York City ... 470
Despard Gas Coal Co., Baltimore, Md ... 471
Westmoreland Coal Co., Phila., Pa ... 471
Berwind-White Coal Mining Co., New York and Phila ... 470

CANNEL COALS.

Perkins & Co., New York City ... 470
Greasy Creek Cannel Coal and Tramway Co., Chicago ... 455

CONVEYORS.

The Link-Belt Machinery Co., Chicago, Ills ... 461

GAS ENRICHERS.

Standard Oil Co., New York City ... 471
The Sun Oil Co., Pittsburgh, Pa ... 471

COKE CRUSHER.

C. M. Keller, Columbus, Ind ... 471

GAS GAUGES.

The Bristol Co., Waterbury, Conn ... 470

GAS GOVERNORS.

Connelly Iron Sponge and Governor Co., New York City 469
Isbell-Porter Co., New York City ... 474
R. D. Wood & Co., Phila., Pa ... 474
Wm. M. Crane Co., New York City ... 457

CEMENTS.

C. L. Gerould, Galesburg, Ills ... 468

RETORTS AND FIREBRICKS.

J. H. Gautier & Co., Jersey City, N. J ... 468
Adam Weber, New York City ... 468
Laclede Firebrick Mfg. Co., St. Louis, Mo ... 468
Cyrus Borgner, Phila., Pa ... 468
James Gardner, Jr., Co., Pittsburgh, Pa ... 468
Henry Maurer & Son, New York City ... 468
Baltimore Retort and Firebrick Co., Baltimore, Md ... 468
Parker-Russell Mining and Mfg. Co., St. Louis, Mo ... 468
Brooklyn Firebrick Works, Brooklyn, N. Y ... 468
Missouri Firebrick Co., St. Louis, Mo ... 468

REGENERATIVE FURNACES.

Bartlett, Hayward & Co., Baltimore, Md ... 473
Fred. Bredel, Milwaukee, Wis ... 462
J. H. Gautier & Co., Jersey City, N. J ... 468
Parker-Russell Mining and Mfg. Co., St. Louis, Mo ... 468
Adam Weber, New York City ... 468
Missouri Firebrick Co., St. Louis, Mo ... 468

SELF-SEALING MOUTHPIECE DOORS.

Isbell-Porter Co., New York City ... 474
Continental Iron Works, Brooklyn, N.Y ... 474
Logan Iron Works, Brooklyn, N. Y ... 476
R. D. Wood & Co., Phila., Pa ... 474

INCANDESCENT GAS LAMPS.

Welsbach Company, Gloucester, N.J ... 460
Kern Incandescent Gas Light Co., New York City.. 460 461

BURNERS.

C. A. Gefroner, Phila., Pa ... 474
Wm. M. Crane Co., New York City ... 461
D. M. Steward Mfg. Co., Chattanooga, Tenn ... 461

LAVA GAS TIPS.

D. M. Steward Mfg. Co., Chattanooga, Tenn ... 461
The Crescent Novelty Mfg. Co., Chattanooga, Tenn ... 456

STREET LAMPS.

Welsbach Street Lighting Co., New York and Phila ... 466
Thos T. W. Miner, New York City ... 457

PURIFIERS.

Stacey Mfg. Co., Cincinnati, O ... 458

PURIFYING MATERIALS.

Connelly Iron Sponge and Governor Co., New York City 469

VALVES.

Ludlow Valve Manufacturing Co., Troy, N.Y ... 470
Chapman Valve Manufacturing Co., Boston, Mass ... 470
R. D. Wood & Co., Phila., Pa ... 474
Continental Iron Works, Brooklyn, N. Y ... 474
The P. H. & F. M. Roots Co., Connersville, Ind ... 463
Isbell-Porter Co., New York City ... 474
The Western Gas Construction Co., Fort Wayne Ind ... 440
Kerr Murray Mfg. Co., Fort Wayne, Ind ... 472

EXHAUSTERS.

The P. H. & F. M. Roots Co., Connersville, Ind ... 463
Isbell-Porter Company, New York City ... 474
Connelly Iron Sponge and Governor Co., New York City 469
Kerr Murray Mfg. Co., Fort Wayne, Ind ... 472

ELECTRICAL APPARATUS.

Wm. Henry White, New York City ... 475

ENGINES AND BOILERS.

The Hazelton Boiler Company, New York City ... 457

PURIFIER SCREENS.

John Cabot, New York City ... 470

GAS STOVES.

American Meter Co., New York and Philadelphia ... 465
Maryland Meter and Manufacturing Co., Baltimore, Md. 478
Keystone Meter Co., Royersford, Pa ... 478
Nathaniel Tufts Meter Co., Boston Mass ... 478
Wm. M. Crane Co., New York City ... 457

HOT WATER HEATERS.

Wm. M. Crane Co., New York City ... 457

GASHOLDER TANKS.

J. P. Whittier, Brooklyn, N. Y ... 473

GASHOLDERS.

Bartlett, Hayward & Co., Baltimore, Md ... 473
Continental Iron Works, Brooklyn, N. Y ... 474
Deily & Fowler, Philadelphia, Pa ... 476
Davis & Farnum Mfg. Co., Waltham, Mass ... 472
Kerr Murray Mfg. Co., Fort Wayne, Ind ... 472
Stacey Mfg. Co., Cincinnati, Ohio ... 475
R. D. Wood & Co., Philadelphia, Pa ... 474
Logan Iron Works, Brooklyn, N. Y ... 476
Riter-Conley Mfg. Co., Pittsburgh, Pa ... 475

STORAGE TANKS.

Chris. Cunningham & Son, Brooklyn, N.Y ... 464

GAS SECURITIES.

Henry Marquand & Co., New York City ... 458

ADVERTISING.

J. Howland Harding, New York City ... 456

BOOKS, ETC.

Newbigging's Handbook ... 477
Field's Analysis, 1899 ... 476
Scientific Books ... 470
Digest of Gas Cases ... 471
Practical Photometry ... 294
Gas Flow Computers ... 476
Hughes' "Gas Works" ... 469
Gas Engineer's Pocket-Book ... 294
Excerpts from Reports of Gas Commissioners ... 479
Binders ... 464
Directory of Gas Companies ... 475
Practical Handbook on Gas Engines ... 477
Coal Tar Tree ... 458
Poole on Fuels ... 306

DIVIDEND NOTICE.

OFFICE OF THE UNITED GAS IMPROVEMENT CO.,
N. W. CORNER BROAD AND ARCH STS.,
PHILA., PA., Sept. 12, 1900.

The Directors have this day declared a quarterly dividend of 2 per cent. (one dollar per share), payable October 13, 1900, to stockholders of record at the close of business, Sept. 29. Checks will be mailed.

1319-4 LEWIS LILLIE, Treasurer.

WANTED,

A SUPERINTENDENT

To take full charge of the entire business of a coal gas company making about 85,000,000 cubic feet per year. A salary of $2,000 will be paid to a competent man, having business and technical experience as manager and superintendent, and also in construction. State age and experience.

1319-1 Address "COMPANY," care this Journal.

Position Wanted

As Superintendent of Small Gas Plant.

Foreman of a gas works desires position as Superintendent of a small gas plant. Coal or water gas. Good mechanic and not afraid of work. Address "G. H. S.,"

1319-2 Care this Journal.

POSITION WANTED
With a Gas Company.

Thoroughly competent young man wishes position with some Gas Company. Has had 18 years' experience meter repairing, gasfitting, setting meters, complaint work, and is familiar with office work and gas work. First-class references and testimonials.

1318-2 Address "F. N.," care this Journal.

Position Wanted
By a Man who is not Afraid of Hard Work.

Has had 20 years' experience in all the departments—manufacturing, distribution, new business and office work.

Address "W."

1296-tf Care this Journal.

Position Wanted
As Manager or Engineer of a Gas Company.

Thoroughly Competent Gas Manager of many years' experience in the manufacturing and the executive ends of a Gas Company desires a position as Manager or Engineer of a Gas Company selling not less than 50,000,000 cubic feet per annum. Highest references given. Address "T."

1267-tf Care this Journal.

FOR SALE.
PURIFIERS.

Two 8 by 10 purifiers, with 8-inch center seal and connections. Center seal made for four purifiers. All in good condition.

Address C. M. KELLER,

1812-tf Columbus, Ind.

FOR SALE,
A New Condenser and Scrubber,

Each 11 feet 6 inches high, 3 feet in diameter, inside measurement, and 6-inch connections—all connections reinforced. Two manholes to scrubber, with two sets of trays; also one 6-inch center valve. These have never been used.

Address PEEKSKILL GAS LIGHT COMPANY,

1300-tf Peekskill, N. Y.

For Sale.
A Small Gas and Electric Light Plant,

in a Southern city of 3,800 inhabitants.

Address FORT WAYNE ELECTRIC CORPORATION,

1097-tf Fort Wayne, Ind.

MESSRS. JONAS DRAKE & SON,
The Well-Known Carbonizing Engineers of Halifax, England,

Are prepared to treat with responsible American Firms for the introduction of their Specialties in Inclined Retorts, Regenerative Furnaces, and the general working of the comprehensive Patents connected therewith in Labor-Saving and Economical Devices, in the United States.

Commnnications to be addressed to

MESSRS. JONAS DRAKE & SON,

1319-4 Ovenden, Halifax. England.

Gas Companies and Gas Appliance Exchanges, Attention!

We will **save** you nearly **30 per cent.** on your **Steatite** or **Lava Gas Tips.**

Manufacturers of all kinds of **Lava Tips** and **Acetylene Gas Burners.**

Headquarters for the **domestic E.H. Tips, superior** to the imported and **lower in price.** All sizes from ⅛ to 12-foot. Address

THE CRESCENT NOVELTY MFG. CO.,
Inventors of the King and Crescent Burner and Sole Manufacturers,
300 Carter Street, Chattanooga, Tenn.

Utilize Your Gas Liquor.
NO EXTRA LABOR OR OPERATING EXPENSES.

Ammonia Concentrator,

Not Expensive. Write to
STROH & OSIUS, Pat'ees, or
Mich. Ammonia Works, Detroit, Mich.

PLANS ADVICE WRITING ILLUSTRATING
J. HOWLAND HARDING, ADVERTISING.
1345 BROADWAY, LONG ACRE SQUARE NEW YORK

TRAYS FOR GAS WORKS
JOHN CABOT
555-557 W. 33rd ST. NEW YORK
Circulars and Prices on Application.

HENRY MARQUAND & CO.,
BANKERS AND BROKERS.

160 Broadway, New York City.

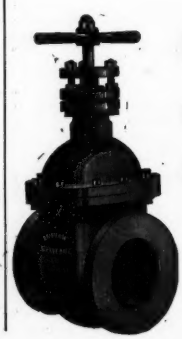
Bristol's Recording
PRESSURE GAUGE.
For continuous records of **Street Gas Pressure.**
Simple in construction, accurate in operation, and low in price.
Fully Guaranteed. Send for Circulars.
THE BRISTOL CO.,
Waterbury, Conn.

KENTUCKY CANNEL COAL, FOR GAS AND DOMESTIC USE

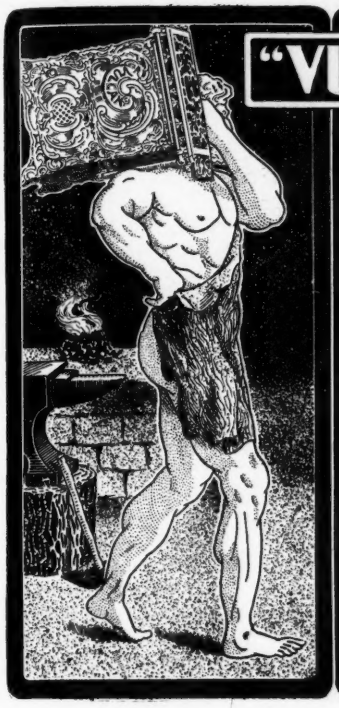
GEO. R. HISLOP, F.C.S., F.R.S.S.A., Gas Engineer of Paisley, Scotland, says in his analysis: "This is a remarkably rich Cannel Coal, yielding illuminating matter per ton equivalent to 1,945 lbs. of sperm candles." This coal mined and shipped in box cars. Write for sample car and delivered price.

The Greasy Creek Cannel Coal and Tramway Co.,
163 WEST WASHINGTON STREET, CHICAGO, ILLS.

CHAPMAN VALVE MANUFACTURING CO.
MANUFACTURERS OF
Valves and Gates for Gas, Ammonia, Water, Etc.
Also, Gate Fire Hydrants with and without Independent Nozzle Valve. All Work Guaranteed.
Works & Gen'l Office, Indian Orchard, Mass. Treasurer's Office, 72 Kilby & 112 Milk Sts., Boston, Mass
Chicago Office, 24 West Lake St. New York Office, 28 Platt St.
St. Louis Office, L. M. Rumsey Mfg. Co., 810 North Second St.



THE
Ludlow Valve Mfg. Co.,
TROY, N. Y., U. S. A.
Double and Single Gate Valves, ¾" to 72",
—FOR—
Gas, Water, Steam, Oil, Ammonia, Etc.
HOT GAS VALVES A SPECIALTY.
Send for Catalogue.



"VULCAN" GAS APPLIANCES

If you have not received our Fall Catalogue **No. 18,** send for copy.

Keep on file No. 17 and No. 18 for full line of Gas Appliances.

Wm. M. Crane Company,

1131-1133 Broadway, New York.

FOUNDRY: PEEKSKILL, N. Y

"THE MINER"

Globe Street and Boulevard Lamps.

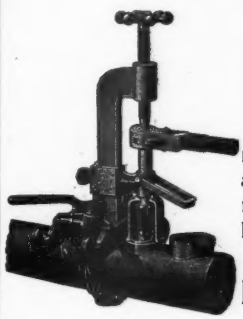
Cheapest and Best.

THOUSANDS IN USE WITH INCANDESCENT BURNERS.

Send for Catalogues.

THOMAS T. W. MINER,

821-823 Eagle Av., N.Y.



B-109.

MUELLER

SPECIAL ATTACHMENT GAS TAPPING MACHINE.

By the use of this attachment to our regular pattern machine your service men are exempt from danger of asphyxia, can make more taps a day, and need less help.

CATALOGUES FROM

H. MUELLER MFG. COMPANY,

DECATUR, ILLS.

GAS TAPPING MACHINES

—FOR—

Drilling and Tapping Pipe under Pressure

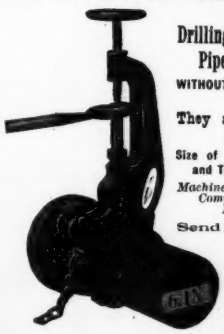
WITHOUT ANY ESCAPE OF GAS.

They are Strong and Compact.

Size of Combination Drills and Taps ⅜ to 4-inch.

Machines Sent to any Gas Company for Thirty Days' Trial.

Send for Circulars.



Geo. Light,

DAYTON, O.

Hazelton Water Tube Boilers.

HIGH PRESSURE.

The Pioneer Vertical Water-Tube Boiler of the World.

Over 11½ Square Feet of Heating Surface per Horse Power.

High Quality and Durability of the Tubes the Most Vital Part of a Boiler.

Fastened at One End Only, Expand and Contract Without Strain, Averting any Possibility of Leakage.

Boilers we Built have been in Constant Use 18 Years, and are in Operation To-day with Fine Results.

10 to 25 Per Cent. Guaranteed Over Other Boilers

Strong, Natural, Upright Draft, Consuming All Kinds of Fuel. Absolutely Dry Steam.

Small Floor Space, Less per Horse Power than for Any Other Boiler.

The **HAZELTON BOILER CO.**

SOLE PROPRIETORS AND MANUFACTURERS,

120 Liberty St., N.Y. Telephone, 1134 Cortlandt

Cable Address, "Palla," N. Y.

AMERICAN BRIDGE CO.,

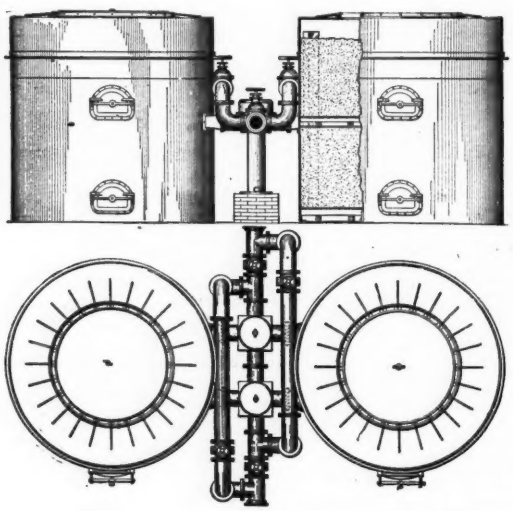
Designers and Builders of Steel Bridges, Steel Buildings and All Classes of Metallic Structures.

GENERAL OFFICES.

No. 100 Broadway, New York.

BRANCH OFFICES.

Boston, Philadelphia, Chicago,
Pittsburg, Baltimore,
New Orleans, Cleveland, Minneapolis.



CHOLLAR'S SYSTEM OF GAS PURIFICATION.

Covered by Five U.S. Patents.

In operation, revivification of the oxide is effected by repeated reversals of the direction of the flow of the gas through the beds (in the two boxes used under this system there are eight different routes for the gas to take) whereby the purified gas is made to revive the oxide in parts of the apparatus while the foul gas is fouling it in others.

The boxes are charged or discharged from the sides as well as the top.

There are no Hydraulic Cups or heavy covers.

Either end of the apparatus is inlet or outlet at pleasure.

The capacity is increased five-fold or more over ordinary methods without addition to building.

The apparatus costs less than for any other system.

For Estimates Write **The Stacey Mfg. Co.,**
SOLE MANUFACTURERS,
FOR FURTHER INFORMATION WRITE CINCINNATI, OHIO.
B. E. CHOLLAR, 411 N. 11th St., St. Louis, Mo.

Coal Tar Genealogical Tree.

Mr. T. Viner Clarke, of London, Eng., having compiled a novel Chart or Map illustrating the various CHEMICAL PRODUCTS DERIVED FROM COAL AND COAL TAR, in the form of a Genealogical Tree, including all the products discovered (the total number amounting to near 700), offers for sale a limited number of copies in Colors, mounted on Linen, with Rollers. Price, $3.50. Orders may be sent to

A. M. CALLENDER & CO., No. 32 Pine Street, New York.

W. H. PEARSON, Prest. W. H. PEARSON, Jr., Vice-President. J. T. WESTCOTT, M.E., Manager. L. L. MERRIFIELD, M.Inst.M.E., Chief Engineer.

THE ECONOMICAL GAS APPARATUS CONSTRUCTION CO., LD.

American Offices: 269 FRONT STREET, EAST, TORONTO, ONT.
London Offices: 19 ABINGDON STREET, WESTMINSTER, S.W.

Telegraphic Address: "CARBURETED LONDON AND TORONTO."

The above Company have erected since 1893, or are now erecting, their universal type of Carbureted Water Gas Plants at the following Gas Works:

	Cubic Feet Daily.
Blackburn, England	1,250,000
Windsor Street Works, Birmingham, England	2,000,000
Saltley Works, Birmingham, England	2,000,000
Colchester, England	300,000
Birkenhead, England	2,250,000
Swindon (New Swindon Gas Company), England	120,000
Saltley Works, Birmingham, England (Second Contract)	2,000,000
Windsor Street Works, Birmingham, England (Second Contract)	2,000,000
Halifax, England	1,000,000
Toronto	250,000
Ottawa	250,000
Toronto (Second Contract, Remodeled)	2,000,000
Lindsay (Remodeled)	125,000
Belleville	250,000
Ottawa (Second Contract)	250,000
Brantford (Remodeled)	200,000
St. Catherine's (Remodeled)	250,000
Kingston, Pa.	125,000
Montreal	500,000
Peterborough, Ont.	250,000
Wilkesbarre, Pa.	750,000
St. Catherine's (Second Contract)	250,000
Buffalo, N. Y.	2,000,000

	Cubic Feet Daily.
Winnipeg, Man.	500,000
Colchester, England (Second Contract)	300,000
York, England	750,000
Rochester, England	500,000
Kingston, Ont.	300,000
Crystal Palace District, England	2,000,000
Duluth, Minn.	300,000
Caterham, England	150,000
Enschede, Holland	150,000
Leicester, England	2,000,000
Buenos Ayres (River Platte Co.)	700,000
Burnley, England	1,500,000
Kingston-on-Thames, England	1,750,000
Accrington, England	500,000
Tonbridge, England	300,000
Stretford, England	500,000
Oldbury, England	300,000
Saltley Works, Birmingham, England (Third Contract)	2,000,000
York, England (Second Contract)	750,000
Rochester, England (Second Contract)	500,000
Newport, Monmouth, England	250,000
Nelson, British Columbia (Complete Gas Works).	

Sutherland Construction & Improvement Co.

Offices: 15 WALL ST., NEW YORK, and OSHKOSH, WISCONSIN.

Owners of the "SUTHERLAND" Patents for Water Gas Apparatus.

Gas, Electric Light, Water Works, and Electric Street Railways Built, Remodeled, Operated, Bought and Sold.

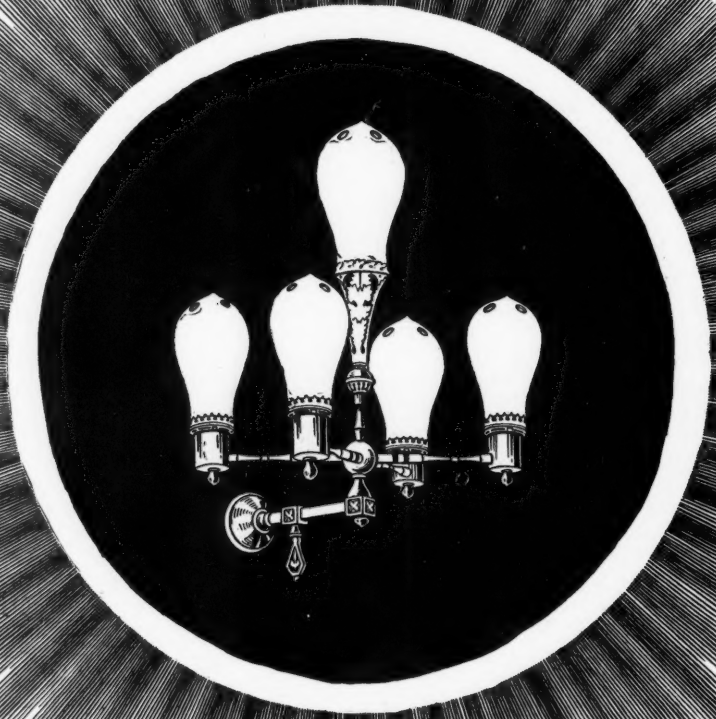
A few of the places where the SUTHERLAND Apparatus is in successful operation:

Ilion, N. Y.
Herkimer, N. Y., 2 orders.
Little Falls, N. Y.
Fishkill-on-Hudson, 2 orders.
Clifton Springs, N.Y., 2 orders.
Green Bay, Wis.
Stevens Point, Wis.
Tarrytown, N.Y., 3 orders.
Ft. Henry, N. Y.
Gainsville, Fla.
Hollidaysburg, Pa.
Waterville, N. Y.
Huntington, L. I.
Lexington, Mo.
Mendota, Ill.
Circleville, O.
Joplin, Mo.
Ashville, N. C.
Youngstown, O.
Kingston & Rondout, N. Y.

CORRESPONDENCE SOLICITED.

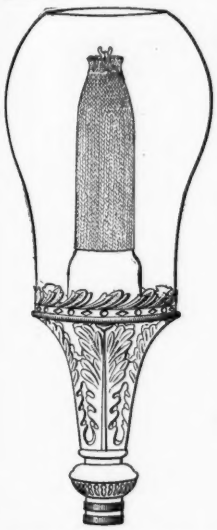
KERN

INCANDESCENT GAS LIGHT CO.



18 MURRAY ST.,

NEW YORK.



Kern Incandescent Gas Light Company's Systems.

NO CHIMNEY. NO BREAKING GLASS.
NO BLACKENED MANTLES.

CAN BE USED WITH

Manufactured Gas, Non-Carburetted Gas, Natural Gas or Gasoline Gas.

35 TO 40 CANDLES PER CUBIC FOOT.

Burner No. 0 consumes	8/10	cu. ft.	.	30-candle power.	Burner No. 3 consumes	3	cu. ft.	.	105 candle power.		
" " 1	"	1	"	. 35 " "	" " 4	"	4	"	. 140	"	"
" " 2	"	2	"	. 70 " "	" " 7	"	7	"	. 225	"	"

Prices Reasonable. Catalogues on Application. Agents Wanted.

KERN INCANDESCENT GAS LIGHT COMPANY,
18 MURRAY STREET, NEW YORK.

Steward Burners.

Closest Attention to **Durability, Candle Power, Finished Appearance.**

Samples to be Had for the Asking.

Write for neat vest pocket memorandum book. Sent Free.

The D. M. Steward Mfg. Co.,

New York Office, 107 CHAMBERS ST. CHATTANOOGA, Tenn.

BRAY BURNERS.

THE THOMAS DAY COMPANY, Distributing Agents for Pacific Coast, San Francisco, Cal.

WILLIAM M. CRANE COMPANY, SOLE AGENTS FOR UNITED STATES, 1131-1133 Broadway, New York.

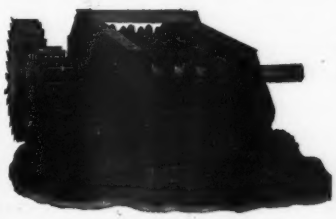
SAFETY GAS MAIN STOPPER CO.

108 EAST 117TH ST., N. Y.

FOR SHUTTING OFF GAS IN MAINS TEMPORARILY DURING ALTERATIONS AND REPAIRS

THE LINK-BELT MACHINERY CO.,

ENGINEERS, FOUNDERS, MACHINISTS,
Chicago, U. S. A.



"Link-Belt" Breaker.

LINK-BELT ELEVATING & CONVEYING MACHINERY for HANDLING COAL, COKE, OXIDE, ETC.

Tilting Coal and Coke Cars, Breaker Rolls, Shaking Screens, Power Transmitting Machinery.

Machinery designed and erected to suit existing conditions and available space.

CATALOGUE UPON APPLICATION.

AMERICAN GAS COMPANY

Constructors of Coal Gas Apparatus.

EASTERN AGENTS FOR

BREDEL'S SYSTEM
COAL GAS PLANTS AND GAS APPARATUS.

P. H. & F. M. ROOTS CO.'S
Exhausters, Governors, etc.

GENERAL AGENTS FOR

BRONDER'S CHARGING AND DISCHARGING MACHINES.

AMERICAN GAS COMPANY,

222 South Third Street, Philadelphia, Pa.

FRED. BREDEL, C.E.

Coal and Water Gas Plants.

OWN SYSTEM.

RECUPERATIVE FURNACES, WASHERS, CONDENSERS, PURIFIERS, PURIFYING MACHINES, COKE CONVEYERS, ETC.

SOLE UNITED STATES AGENT FOR
ARROL-FOULIS MECHANICAL CHARGING AND DRAWING MACHINES.

Gas Enriching Plants to Enrich Coal Gas up to 24 Candle Power, and Making a White, Bright, Non-smoking Gas.

GAS RETORTS AND SPECIAL BLOCKS AND FIREBRICK MANUFACTURED UNDER THE SUPERINTENDENCE OF MY OWN CHEMIST.

COMPLETE GAS WORKS

No. 118 Farwell Avenue, · Milwaukee, Wis.

Eastern Agents: AMERICAN GAS CO., Construction Department, 222 So. 3d St., Phila., Pa.

ROOTS'

LATEST IMPROVED GAS EXHAUSTER

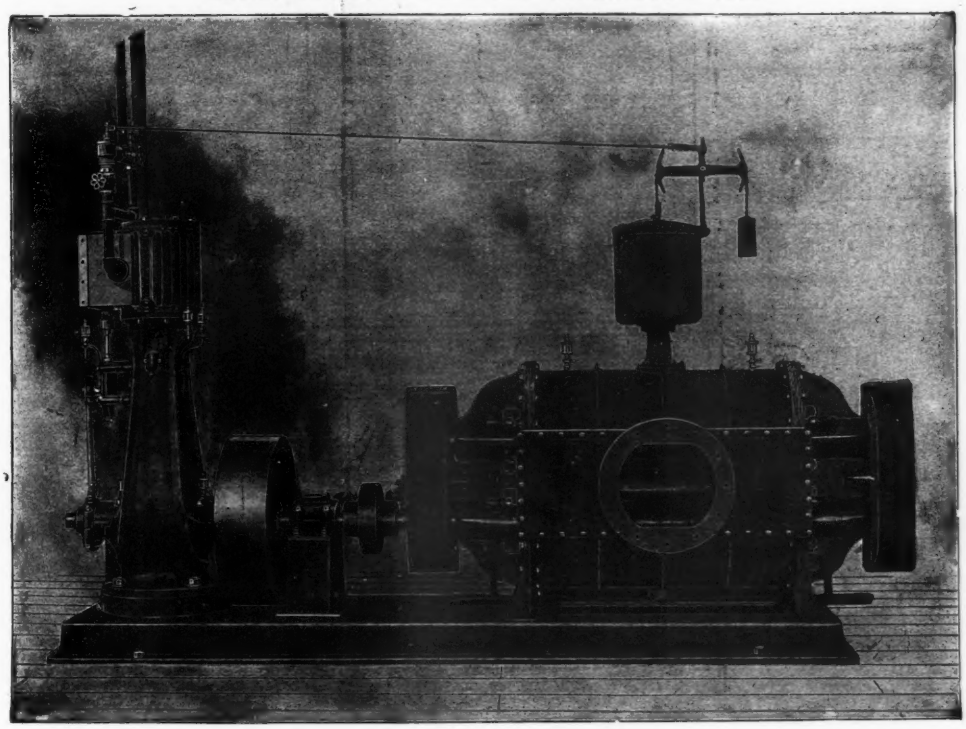
—AND—

NEW GAS GOVERNOR AND STEAM VALVE.

GUARANTEED TO REGULATE WITHIN ONE-TENTH OF AN INCH, WATER PRESSURE.

The Most Perfect Gas Governor on the Market.

MORE DIRECT IN ACTION. FEWER PARTS.
EASIER TO ADJUST THAN ANY OTHER GOVERNOR.



INQUIRIES CHEERFULLY ANSWERED. WRITE FOR CATALOGUE.

P. H. & F. M. ROOTS CO.,

Connersville, Ind. 109 Liberty St., New York.

Eastern Office:

American Gas Company,

222 South Third Street, Philadelphia, Pa.

WARREN FOUNDRY AND MACHINE CO.,

Established 1856. Works at Phillipsburgh, N. J.

New York Office, 160 Broadway.

CAST IRON WATER AND GAS PIPE,

From Three to Forty-Eight Inches Diameter. Also, all Sizes of

Flange Pipe for Sugar House and Mine Work. Branches, Bends, Retorts, etc., etc.

"Rose Specials" Patented. "Llanberis" Fire Pipes.

M. J. DRUMMOND & CO.

MANUFACTURERS OF

CAST IRON FLANGE GAS and WATER PIPE

GENERAL SALES OFFICE, 192 BROADWAY, NEW YORK.

Western Office: Monadnock Block, Chicago, Ills.

George Ormrod, Manst. & Treas., Emaus, Pa.
John Donaldson, Prest., Betz Bldg., Phila., Pa.

EMAUS PIPE FOUNDRY.

DONALDSON IRON COMPANY. EMAUS, PA.

MANUFACTURERS OF

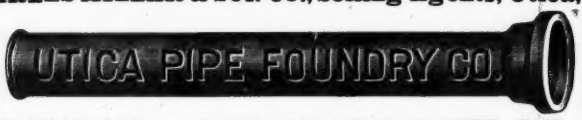
CAST IRON PIPE AND SPECIAL CASTINGS

FOR WATER AND GAS.

Also, FLANGE PIPE, LAMP POSTS, Etc.

CHARLES MILLER & SON CO., Selling Agents, Utica, N.Y.

Flanged Pipe and Fittings, Hydrant, Gates, Pig Lead, Jute, etc.



Manufacturers of Lead Pipe, Sheet, Bar and Solders of Plumbers' and Tinners' Goods.

CAST IRON PIPE and SPECIALS FOR WATER AND GAS.

Wholesale Eastern Agents AKRON VITRIFIED SEWER PIPE.

CORNELL & UNDERHILL,

Wrought & Cast Iron Pipe,

MALLEABLE AND CAST IRON FITTINGS,

Brass and Iron Cocks and Gate Valves,

43, 45 AND 47 BEACH ST., NEW YORK.

BINDER for the JOURNAL.

Price, $1.00.

A. M. CALLENDER & CO., 32 Pine Street, N.Y.

CHRIS. CUNNINGHAM & SON,

PROPRIETORS,

THE NOVELTY STEAM BOILER WORKS,

BROOKLYN, N. Y.

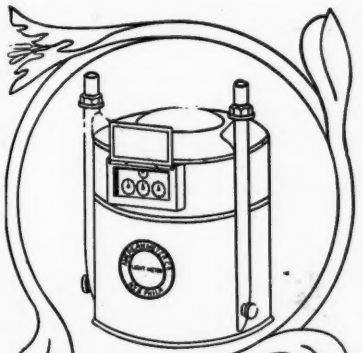
STORAGE TANKS FOR GAS WORKS,

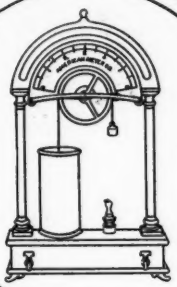
To Retain Fluid Material of Any Sort.

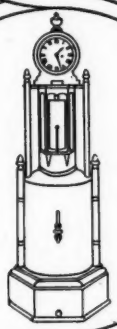
PIPING IN AND AROUND GAS WORKS.

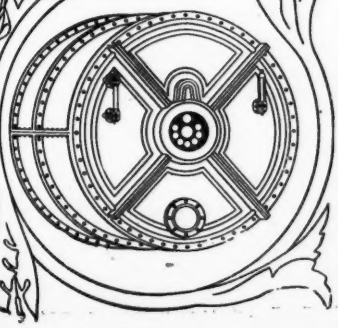
Work Done for Several of the Largest Gas Companies in America Stands as Reference.

(Copyrighted, 1894, by the AMERICAN METER CO.









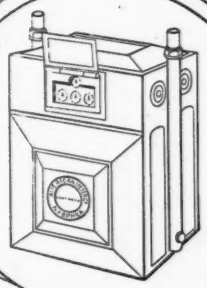
AMERICAN METER CO.

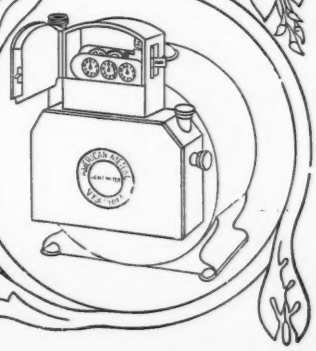
ESTABLISHED 1836. INCORPORATED 1863.

NEW YORK AND PHILADELPHIA,

CHICAGO, ST. LOUIS,

SAN FRANCISCO.





PUBLIC LIGHTING TABLE.

OCTOBER, 1900.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P.M.	A.M.
Mon.	1	10.00 FQ	5.00 AM	5.30	5.00
Tue.	2	11.00	5.00	5.30	5.00
Wed.	3	12.10 AM	5.00	5.30	5.00
Thu.	4	1.20	5.00	5.30	5.00
Fri.	5	2.40	5.00	5.30	5.00
Sat.	6	3.50	5.00	5.30	5.00
Sun.	7	No L.	No L.	5.30	5.00
Mon.	8	No L. FM	No L.	5.20	5.10
Tue.	9	No L.	No L.	5.20	5.10
Wed.	10	6.00 PM	7.50 PM	5.20	5.10
Thu.	11	6.00	8.40	5.20	5.10
Fri.	12	6.00	9.40	5.20	5.10
Sat.	13	6.00	10.40	5.20	5.10
Sun.	14	5.50 LQ	11.40	5.20	5.10
Mon.	15	5.50	12.40 AM	5.10	5.20
Tue.	16	5.50	1.40	5.10	5.20
Wed.	17	5.50	2.40	5.10	5.20
Thu.	18	5.50	3.40	5.10	5.20
Fri.	19	5.50	4.30	5.10	5.20
Sat.	20	5.50	5.20	5.10	5.20
Sun.	21	5.40	5.20	5.10	5.20
Mon.	22	5.40	5.20	5.00	5.30
Tue.	23	5.40 NM	5.20	5.00	5.30
Wed.	24	5.40	5.20	5.00	5.30
Thu.	25	5.40	5.20	5.00	5.30
Fri.	26	5.40	5.20	5.00	5.30
Sat.	27	5.40	5.20	5.00	5.30
Sun.	28	7.50	5.30	5.00	5.30
Mon.	29	8.50	5.30	4.45	5.35
Tue.	30	10.00 FQ	5.30	4.45	5.35
Wed.	31	11.00	5.30	4.45	5.35

TOTAL HOURS LIGHTING DURING 1900.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	230.50	January	423.20
February	175.40	February	355.25
March	189.00	March	355.35
April	160.30	April	298.50
May	150.40	May	264.50
June	137.00	June	234.25
July	152.00	July	243.45
August	171.50	August	280.25
September	187.20	September	321.15
October	213.10	October	374.30
November	221.50	November	401.40
December	231.50	December	433.45
Total, yr.	2221.40	Total, yr.	3987.45

NEW YORK, 33 Nassau St. PHILADELPHIA, Broad and Arch Sts. CHICAGO, 54 Lake St.

Welsbach Street Lighting Company

.... OF AMERICA ....

No. 36.

Controls and Operates the

Welsbach System of Street Lighting,

Which includes its specially DESIGNED AND PATENTED BURNER for STREET and PARK LIGHTING exclusively.

Uniformly SUCCESSFUL in seventy-five Cities and Towns.

By means of the Welsbach System of street lighting the superiority of GAS over electricity for street lighting has been fully demonstrated.

POINTS OF MERIT:

It is { Economical, Attractive, Successful, Up-to-date.

IT LIGHTS THE STREET.

Where there are no gas mains we can furnish an equally good light by our SELF-GENERATING NAPHTHA WELSBACH BURNER, and thereby supply a uniform light in all localities.

No. 38.

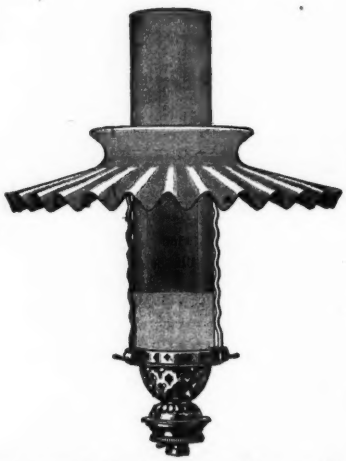
Correspondence solicited from Gas Companies and others interested in Municipal and outside lighting.

Welsbach Famous Mantles.

THE INCOMPARABLE

"USEA" Welsbach MANTLE

FINEST EXAMPLE OF INCANDESCENT GAS LIGHT EVER EXHIBITED.



OTHER WELSBACH BRANDS —OF— Magnificent Brilliancy —AND— Endurance.

THE HIGHEST ILLUMINATION, The Lowest Cost.

Welsbach Lamps, Mantles, and Complete Line of Glassware and Supplies

WELSBACH COMPANY,

GLOUCESTER, N. J.

Chicago Branch Department and Supply House, - - - - - 70 Wabash Avenue.

THE UNITED GAS IMPROVEMENT COMPANY.

THE STANDARD DOUBLE SUPERHEATER LOWE WATER GAS APPARATUS.

CONTRACTS RECEIVED SINCE JANUARY 1, 1900.

	SETS.		SETS.
DANSVILLE, N. Y.	1	CARBONDALE, PA.	1
WEST CHESTER, PA.	1	HACKENSACK, N. J.	1
COHOES, N. Y.	2	TIFFIN, O.	1
OGDEN GAS CO., CHICAGO	1	MOUNT HOLLY, N. J.	1
CENTRAL UNION GAS CO., NEW YORK	1	SEATTLE, WASH.	1
SPENCER, MASS.	1	TARRYTOWN, N. Y.	1
SAN FRANCISCO	1	HOBOKEN, N. J.	2
BROOKLYN UNION GAS CO., BROOKLYN	1	PATERSON, N. J.	2
RICHMOND, VA.	2	NEWARK, N. J.	2
CAMBRIDGE, MASS.	2	JERSEY CITY, N. J.	1

NUMBER OF SETS 26
TOTAL SETS INSTALLED TO JANUARY 1, 1900 327

TOTAL SETS INSTALLED TO DATE 353
TOTAL DAILY CAPACITY . . . . . 226,600,000 Cubic Feet.

The United Gas Improvement Company,

Broad and Arch Streets, Philadelphia.

Established 1858. Incorporated 1890.
CHAS. E. GREGORY Prest. DAVID R. DALY V. Prest. & Treas. H. D. ABERNETHY. Sec.

J. H. Gautier & Co.

Greene & Essex Streets,
Jersey City, N. J.

MANUFACTURERS OF

CLAY GAS RETORTS, FIRE CLAY TILES, FIRE BRICK and FIRE CLAY SPECIALTIES.

Ground Fire Clay, Fire Sand and Ground Fire Brick in Barrels and Bulk.

SOLE MANUFACTURERS OF THE

FLEMMING GENERATOR GAS FURNACE

E. D. WHITE, President. A. H. GUTKES, Vice-President. H. A. PERKINS, Secretary.

Brooklyn Fire Brick Works,

MANUFACTURERS OF

CLAY RETORTS, FIRE BRICK, Gas House and other Tile.

Office, 88 Van Dyke St. Brooklyn, N. Y.

Established 1854. Incorporated 1869.

LACLEDE Fire Brick Manufg. Co.,

Manufacturers of GAS RETORTS . . FIRE BRICK . . . RETORT SETTINGS

Water Gas Cupola Linings, Fire Clay, Etc.

Proprietors for the U. S., Coze System of Inclined Benches.

Estimates Furnished on Application for Most Successful Style of Construction.

Also for Free-Firing and Full and Half-Depth Regenerative Benches, for Burning either Coal or Coke in the Furnaces.

Office: 914, 915 & 916 Wainwright Building, St. Louis, Mo.

The Construction of Gas Works

PRACTICALLY DESCRIBED,

By WALTER RALPH HERRING.

Price $2. For Sale by

A. M. CALLENDER & CO.,

32 Pine Street, N. Y. City.

Adam Weber,

Proprietor,

Manhattan Fire Brick and Enameled Clay Retort Works.

Works, Weber, N. J.

Office, 633 East 15th St., New York.

Modern Recuperative Furnaces

And Standard Fire Brick and Gas Retorts.

Works, LOCKPORT STATION, PA.

—ESTABLISHED 1864.—

JAMES GARDNER, JR., CO.,

Hamilton Building, Fifth Avenue, PITTSBURGH, PA. P. O. Box 373.

Successor to WILLIAM GARDNER & SON,

Fire Clay Goods for Gas Works.

SOLE REPRESENTATIVE OF THE McILHENNY REGENERATIVE BENCHES FOR THE U. S.

HENRY MAURER & SON,

(ESTABLISHED 1856.)

EXCELSIOR FIRE BRICK & CLAY

RETORT WORKS

WORKS, Perth Amboy, N. J.

OFFICE, 418 to 422 East 23d St., N. Y.

Clay Gas Retorts,

BENCH SETTINGS,

Fire Brick, Tiles, Etc.

GEROULD'S IMPROVED RETORT CEMENT

A Cement of great value for patching retorts, putting on mouthpieces, making up all bench-work joints, lining blast furnaces and cupolas. This cement is mixed ready for use. Economic and thorough in its work. Fully warranted to stick.

Price List, f.o.b. Galesburg, Ills., or Buffalo, N. Y.

In Casks, 400 to 800 pounds, at 5 cents per pound.
In Kegs, 100 to 200 " " 6 " "
In Kegs less than 100 " " 7 " "

C. L. GEROULD, Galesburg, Ills.

For orders East of Buffalo, N. Y., or Pittsburg, Pa., freight will be paid to these points.

Parker-Russell Mining and Mfg. Co.,

CITY OFFICE,

417 Pine Street, St. Louis, Mo.

PROPRIETORS OF THE

OAKHILL GAS RETORT & FIRE BRICK W'KS

Our immense establishment is now employed almost entirely in the manufacture of

Materials for Gas Companies

We have studied and perfected three important points. Our retorts are made to stand changes of temperature, the strongest heats of the furnace, and the abrasion of feeding and emptying. We construct

Half and Full Depth Benches of Our Own Design,

Containing 6, 8 or 9 Retorts.

We have Greatly Improved our Recuperators. Coal or Coke can be used as Fuel in Furnaces.

THEO. J. SMITH, Prest. J. A. TAYLOR, Sec.
A. LAMBLA, Vice-Prest. and Supt.

BALTIMORE RETORT & FIRE BRICK CO.

MANUFACTORY AT

LOCUST POINT BALTIMORE MD.

Clay Retorts, Blocks & Tiles

FIRE BRICK, FIRE CLAY, AND FIRE CEMENT.

Red and Buff Ornamental Tiles and Chimney Tops. Baker Oven Tiles 12x12x2 and 10x10x2.

WALDO BROS., 102 MILK ST., BOSTON, MASS.

Sole Agents for New England States.

JOHN DELL, General Manager.

MISSOURI FIRE BRICK CO.,

ESTABLISHED 1882.

MANUFACTURERS OF

Gas Retorts, Bench Settings, Fire Brick, Cupola Linings, Etc.

We are prepared to furnish and erect COMPLETE, Half and Full Depth Benches of 6's, 8's, 9's, with Regenerative Furnaces, Constructed to Burn either Coal or Coke. Also Plain Benches.

CORRESPONDENCE IS RESPECTFULLY SOLICITED.

CITY OFFICE: 411 Olive St., Continental Bank, ST. LOUIS, MO.

National Gas and Water Company.

CONTRACTORS FOR
Gas Plant Machinery

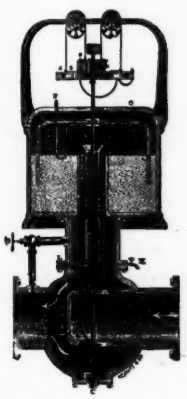
SOFT COAL OR COKE
WATER GAS GENERATORS
A SPECIALTY.

218 LA SALLE ST.,
CHICAGO.

Gas Engineers
INSPECTION AND ADVICE.

PLANS AND ESTIMATES
FOR IMPROVEMENTS OR
REPAIRS.

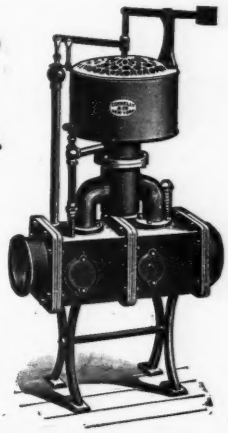
GAS WORKS SPECIALTIES,



AUTOMATIC STREET GAS GOVERNORS,
BALANCE GAS GOVERNORS.
"Iron Sponge" and Natural Oxide
FOR GAS PURIFICATION.
EXHAUSTERS, ETC.

Connelly Iron Sponge & Governor Co.

No. 357 CANAL STREET,
NEW YORK CITY.



WESTERN BRANCH CONNELLY IRON SPONGE & GOVERNOR CO.,
788 South Canal Street, Chicago, Ills.

Hughes'
"Gas Works,"

Their Construction and Arrangement,

And the Manufacture and Distribution of Coal Gas.

Originally written by SAM'L HUGHES, C.E.

Rewritten and Much Enlarged by
WM. RICHARDS, C.E.

Eighth Edition, Revised, with Notices of Recent Improvements.

Price, $1.65.

A. M. CALLENDER & CO.,
32 Pine St., N. Y. City.

Parson's Steam Blower

FOR IMPROVING BAD DRAUGHT IN BOILERS, AND FOR BURNING BREEZE OR OTHER WASTE MATERIAL.

PARSON'S TAR BURNER,

FOR USING COAL TAR AS FUEL.

PARSON'S AIR JET TUBE CLEANER,

FOR CLEANING BOILER TUBES.

These devices are all first-class. They will be sent to any responsible party *for trial*. No sale unless satisfactory. Manufactured by the WATERTOWN STEAM BLOWER COMPANY.

H. E. PARSON, Supt., 457 Putnam Ave., Brooklyn, N. Y.

The Chemistry of Illuminating Gas,
By NORTON H. HUMPHRYS. Price, $2.40.
A. M. CALLENDER & CO., 32 PINE ST., N. Y. CITY.

The Gas Engineer's Laboratory Handbook,
By JOHN HORNBY, F.I.C.
Price, $2.50.
A. M. CALLENDER & CO., 32 Pine Street N Y City

Practical Hints on the Construction and Working of Regenerator Furnaces,
By MAURICE GRAHAM, Assoc M. Inst. C.E.
Price, $1.25. For Sale by
A. M. CALLENDER & CO., No. 32 Pine Street, New York City.

JAMES D. PERKINS, President. F. SEAVERNS, Treasurer.

THE PERKINS COMPANY,

228 and 229 Produce Exchange, New York City.

TIDEWATER SALES AGENTS FOR THE FOLLOWING:

Ocean Mine Youghiogheny Gas Coal,
Old Kentucky Shale and O. K. Boghead.

SHIPMENTS FROM NEW YORK, PHILADELPHIA, BALTIMORE AND NORFOLK.

BERWIND-WHITE COAL MINING COMPANY'S

Ocean Westmoreland Gas Coal.

Offices:
Washington Building, New York.
Betz Building, Philadelphia.

STRICTLY High Grade. . . . .
Carefully prepared.
For Gas Making or
Heavy Steaming.

SCIENTIFIC BOOKS.

GAS MANUFACTURE, THE CHEMISTRY OF, by W. J. A. Butterfield. $3 50.

NEWBIGGING'S HANDBOOK. By Thos. Newbigging. 6th edition. $6.

COX'S GAS FLOW COMPUTER. $2.50.

FIELD'S ANALYSIS, 1898. $5.

HUGHES' GAS WORKS. $1.65.

POOLE ON FUELS. By Herman Poole. $3.

GAS ENGINEER'S POCKET-BOOK. By Henry O'Connor. $3.50.

TECHNICAL GAS ANALYSIS. $3.

GAS CONSUMER'S HANDYBOOK, by Wm. Richards. 20 cents.

CHEMISTRY OF ILLUMINATING GAS. By Norton H. Humphrys. $2.40.

PRACTICAL TREATISE ON HEAT By Thomas Box. 2d edition. $5.

PRACTICAL PHOTOMETRY: A Guide to the Study of the Measurement of Light. By W. J. Dibdin. $3.

CHEMICAL TECHNOLOGY: Vol. I., *Fuel and Its Applications*, $5. Vol. II., *Lighting*, $4.

IRONWORK: Practical Designing of Structural Ironwork. By H. Adams. $2.50.

HEMPEL'S GAS ANALYSIS, $2.

LIQUID FUEL FOR MECHANICAL AND INDUSTRIAL PURPOSES. By E. A. Brayley Hodgetts. $2.50.

COAL: Its History and Use. By Prof. Thorpe. $3.50.

PRACTICAL HANDBOOK ON GAS ENGINES, by G. Lieckfeld. $1.

HEAT A MODE OF MOTION. By John Tyndall. $2.50.

THEORY OF HEAT. By J. Clerk-Maxwell. $1.50.

MANUAL FOR GAS ENGINEERING STUDENTS. By D. Lee. 40 cents.

GASFITTER'S GUIDE, by John Eldridge 40 cents.

AMMONIA AND AMMONIUM COMPOUNDS. By Dr. R. Arnold. $2

CONSTRUCTION OF GAS WORKS, by Walter Ralph Herring. $2.

DIGEST OF GAS CASES. $5.

PRACTICAL HINTS ON REGENERATOR FURNACES By M. Graham. $1.25.

A TREATISE ON THE COMPARATIVE COMMERCIAL VALUES OF GAS COALS AND CANNELS. By D. A. Graham. $3.

A TEXT BOOK OF INORGANIC CHEMISTRY. By Prof. Victor Von Richter. $2.

ILLUMINATING AND HEATING GAS. By W. Burns. $1.50

HANDBOOK FOR MECHANICAL ENGINEERS. By H. Adams. $2.50.

TREATISE ON MASONRY CONSTRUCTION. Baker. $5

GAS ENGINEER'S LABORATORY HANDBOOK. By Jno. Hornby. $2.50.

GAS LIGHTING AND GAS FITTING. By W. P. Gerhard. 50 cents.

PRACTICAL PLUMBING. By P. J. Davies. $3.

AMERICAN PLUMBING. By Alfred Revill. $2.

CEMENT; A Manual of Lime and Cement, their Treatment and Use in Construction. By A. H. Heath. $2.50.

A COMPARISON BETWEEN THE ENGLISH AND FRENCH METHODS OF ASCERTAINING THE ILLUMINATING POWER OF COAL GAS. $1.60.

ELECTRICITY.

INDUSTRIAL PHOTOMETRY, with Special Application to Electric Lighting. By A. Palaz, Sc.D. $4.

ELEMENTS OF ELECTRIC LIGHTING, Including Electric Generation, Measurement, Storage and Distribution. By Philip Atkinson. $1.50.

ELECTRIC TRANSMISSION OF ENERGY. By G. Kapp. $3.50.

ELECTRICIAN'S POCKETBOOK. By Monroe and Jamieson. $2.50.

DYNAMO BUILDING. By F. W. Walker. 50 cents.

DOMESTIC ELECTRICITY FOR AMATEURS. By E. Hospitalier. $2.50.

PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS. $1.

PRACTICAL GUIDE TO THE TESTING OF INSULATED WIRES AND CABLES. $1.

ELECTRIC LIGHTING, by Francis B. Crocker. $3.

ELECTRIC LIGHT FITTING. $2.

PRACTICAL ELECTRICITY. $2.50.

ELECTRICITY FOR ENGINEERS. $2.50.

ELECTRICITY, Its Theory, Sources and Applications. By John T. Sprague. $6.

The above will be forwarded upon receipt of price. If sent by mail or express, postage or express charges must be added to above prices. We take especial pains in securing and forwarding any other Works that may be desired, upon receipt of order. All remittances should be made by check, draft, or post office money order. No books sent C.O.D.

A. M. CALLENDER & CO., 32 Pine Street, New York.

The Despard Gas Coal Co.,

MINERS AND SHIPPERS OF

DESPARD GAS COAL,

AND MANUFACTURERS OF

COKE.

MINES, - - Clarksburgh, Harrison Co., West Va.
WHARVES, - - - Locust Point Baltimore, Md.
OFFICE, - 640 Equitable Building Baltimore, Md.

RCUSSEL & HICKS, 71 Broadway, N. Y. } AGENTS, { BANGS & HORTON 60 Congress St., Boston

KELLER ADJUSTABLE COKE CRUSHER.

Strong, Simple, Durable. Will Crush any Size Desired.

C. M. KELLER.
Sec. & Supt. Gas Lt. & Coke Co.,
Columbus, Ind.
Correspondence Solicited.

Do You Wish to Know

what size of pipe to use to convey any quantity of gas, any distance, with any loss of pressure and any initial or final pressure? Then use

Cox's Gas Flow Computer,

as it gives this information accurately at sight, without mental effort. No calculations needed. Saves time, money and mistakes.

Price, 6.5 x 8 inches, in cloth case, $2.50. For sale by

A. M. Callender & Co., 32 Pine St., N. Y.

GREENOUGH'S

"DIGEST OF GAS CASES."

Price, $5.00.

This is a valuable and important work, a copy of which should be in the possession of every gas company in the country, whether large or small. As a book of reference it will be found invaluable. It is the only work of the kind which has ever been published in this country, and is most complete. Handsomely bound. Orders may be sent to

A. M. CALLENDER & CO., 32 Pine St., N. Y.

MADEIRA, HILL & CO.,

INCORPORATED.

MINERS AND SHIPPERS

Anthracite and Bituminous Coal and Coke.

GENERAL EASTERN SALES AGENTS

PENN GAS COAL CO.

OPERATING THE FAMOUS MINES IN THE

YOUGHIOGHENY COAL BASIN.

OWNERS OF OVER 1,000 COAL CARS.

COAL CAREFULLY SCREENED AND PREPARED FOR GAS PURPOSES.

OFFICES:

PHILADELPHIA, 32 South Broad Street. BOSTON, 70 Kilby Street. NEW YORK, 143 Liberty Street.
BRIDGEPORT, CONN. READING, PA.

EDMUND H. McCULLOUGH, Pres't. CHAS. F. GODSHALL, Treas. H. C. ADAMS, Sec.

THE WESTMORELAND COAL CO.

Chartered 1854.

Mines situated on the Pennsylvania and the Baltimore and Ohio Railroads, in Westmoreland County, Pa.

POINTS OF SHIPMENT:

PHILADELPHIA, BALTIMORE, SOUTH AMBOY, N. J.,
WATKINS (SENECA LAKE), N. Y.

Since the commencement of operations by this Company its well-known Coal has been largely used by the Gas Companies of New England and the Middle States, and its character is established as having no superior in gas-giving qualities, and in freedom from sulphur and other impurities.

Principal Office, 224 South 3d St., Phila., Pa.

THE SUN OIL CO.,

Crude Oil, Gas Naphtha,
Refined Petroleum, Gas Oil.

Toledo, O., and Pittsburgh, Pa.

Standard Oil Company,

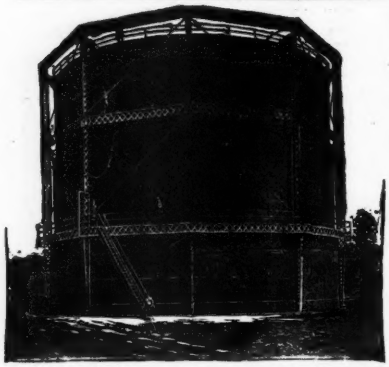
GAS NAPTHA DEPARTMENT.

GAS NAPTHA.

GAS OIL.

Correspondence Solicited.

26 Broadway, New York City.



DAVIS & FARNUM MFG. CO.,

WALTHAM, MASS.

Principal Office & Works, Waltham, Mass. Boston Office, R'm 18, Vulcan Bldg., 8 Oliver St.

Single, Double and Triple-Lift Gasholders of any Capacity. Tubular, Pipe and Sinuous Friction Condensers of all Sizes.

Steel Tanks for Gasholders, Iron Roof Frames and Floors Purifying Boxes, Center Seal or Valve Connections, Bench Work, Reversible Lime Trays.

Self-Sealing and Pressed Steel Mouthpiece Lids.

Coke Borrows, Coal Wagons, and all Apparatus Requisite for a Complete Gas Works.

Also, Gas and Water Pipe, Flanged Pipe, Sugar House Work, and Special Castings of all Descriptions.

BAXTER & YOUNG,

CONTRACTING AND CONSULTING GAS ENGINEERS.

Examination and Values Ascertained of Artificial and Natural Gas Properties.

COMPLETE GAS WORKS ERECTED.

Artificial and Natural Gas Mains Furnished and Laid.

CORRESPONDENCE SOLICITED.

OFFICE: WAYNE COUNTY BANK BUILDING,

Rooms 201 & 202. DETROIT, MICH.

A. E. BOARDMAN, C. E.,

Consulting and Contracting Engineer.

Particular attention given to Gas, Water and Electric Plants. Long and successful experience with the problem and practice of

Filtration for Public Water Supply.

BREVARD, N. C.

Geo. Shepard Page's Sons.

GAS MACHINERY.

Correspondence Solicited.

180 Fulton Street, New York City.

JAMES T. LYNN,

GAS ENGINEER AND CONTRACTOR,

Wayne Bank Building, - DETROIT.

GAS PROPERTIES PURCHASED.

DAVID LEAVITT HOUGH,

Consulting Engineer AND CONTRACTOR,

374 FIFTH AVE., N. Y.

Kerr Murray Manufacturing Company,

Steel Gasholder Tanks,

SINGLE, DOUBLE AND TRIPLE-LIFT GASHOLDERS,

HORIZONTAL AND VERTICAL STORAGE OIL TANKS

Iron Work for Coal Gas Benches, Self-Sealing Mouthpieces, Exhausters, Condensers, Scrubbers, Purifiers, Wooden Trays, Floor Carriages, Center Seal and Valve System Connections, Cast and Wrought Iron Fittings, and Connections 3 to 36 Inches Diameter.

VALVES, Double Gate, Hub and Flange, Outside Screw and Quick Opening, 3 to 36 In. Diam.

COAL AND COKE WAGONS, RETORT HOUSE TOOLS, STREET MAIN SPECIALS AND DRIPS.

Address,

KERR MURRAY MANUFACTURING CO.

Fort Wayne, Indiana.

BARTLETT, HAYWARD & CO.

BALTIMORE, MD.

Triple, Double and Single-Lift Gasholders.

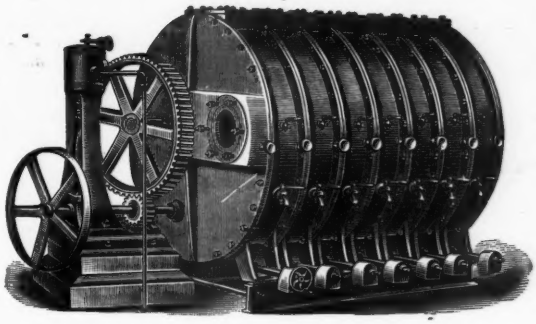
Iron Holder Tanks.

ROOF FRAMES.

Girders.

BEAMS

PURIFIERS.



CONDENSERS.

Scrubbers.

Bench Castings.

OIL STORAGE TANKS

Boilers.

PATENT STANDARD WASHER-SCRUBBER.

The best apparatus for the extraction of all Ammonia and a large proportion of Carbonic Acid and Sulphureted Hydrogen. The Scrubber has been materially improved and is provided with patented Wooden Segmental Grids, instead of Metallic Discs, thus reducing the weight on shaft and power for operating same

The Wilkinson Water Gas Process.

THIRTY-CANDLE, NON-CONDENSABLE, FIXED GAS. THE MOST SUCCESSFUL GAS PROCESS IN OPERATION.

MILL'S REVERSIBLE LIME TRAYS.

Gas Works Designed and Constructed.

ALEX. C. HUMPHREYS, M.E., M. Inst. C.E. ARTHUR G. GLASGOW, M.E., M. Inst. C.E.

HUMPHREYS & GLASGOW,

BANK OF COMMERCE BLDG., 31 Nassau Street, New York.

9 VICTORIA STREET, London S.W., England.

CONSULTING GAS ENGINEERS AND MANAGERS.

GAS PROPERTIES PURCHASED.

GASHOLDER TANKS AND GAS WORKS MASONRY COMPLETE

Plans prepared and Estimates furnished at short notice.

J. P. WHITTIER,

238 Java Street, Brooklyn, N. Y.

GEORGE R. ROWLAND.

Formerly with the Continental Iron Works.

Draughtsman and Constructing Engineer.

Drawings, Specifications and Estimates furnished for the construction of new works or alteration of old works. Special attention given to Patent Office drawings.

Office, No. 245 Broadway, N. Y. City.

R. D. WOOD & CO.,

400 CHESTNUT ST., PHILADELPHIA,

Producer Gas Power Plants,

—WITH—

GAS PRODUCERS.

The best Producer for either Bituminous, Anthracite Coal or Lignite. Less labor required and less waste than any other Producer. Patented in the United States and all Foreign Countries. Send for Pamphlet.

HYDRAULIC TOOLS. **CAMDEN HIGH PRESSURE VALVES.**

ISBELL-PORTER CO.,

ENGINEERS AND CONTRACTORS FOR THE

Construction and Extension of Gas Works.

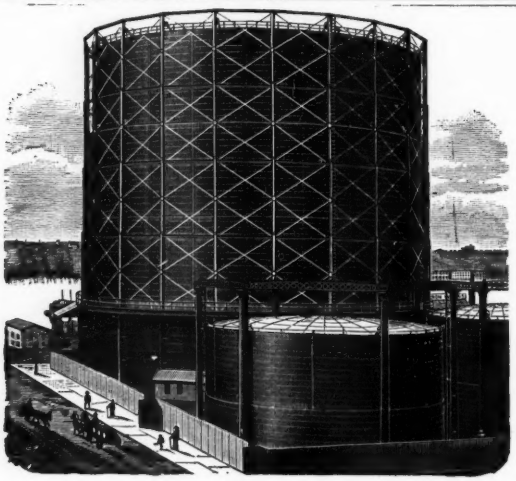
FOUNDERS AND MACHINISTS.

MANUFACTURERS OF

All Ironwork and Machinery Required in a Gas Plant.

Estimates, Drawings and Specifications furnished for the Alteration, Improvement, or Extension of Existing Works or the Construction of New Works.

245 Broadway, New York City. —OFFICES— **Bridge & Ogden Sts., Newark, N. J.**



The Continental Iron Works,

THOMAS F. ROWLAND, President
WARREN B. HILL and CHAS. H. CORBETT, Vice-Presidents.
THOMAS F. ROWLAND, Jr., Secretary & Treasurer.

West and Calyer Sts. (Near 10th & 23d St. Ferries)
NEW YORK, Borough of Brooklyn.

BUILDERS OF

Gas Holders.

Single and Multiple Section Gas Holders a Specialty.

STEEL GAS HOLDER TANKS.

BENCH CASTINGS, RETORT LIDS.

Hydraulic Mains, Condensers, Scrubbers, Purifiers, Valves, Etc.

Self-Sealing Retort Mouthpieces & Lids

For Round, Oval, or "D" Retorts.

ILLUMINATING GAS! FUEL GAS!

THE LOOMIS PROCESS.

Now in successful operation at Works of John Russell Cutlery Co., Turner's Falls, Mass., and Henry Disston's Son's Saw Works, Tacony, Pa.

The Cheapest Gas Generating System in the World.

Plans and Estimates Furnished.

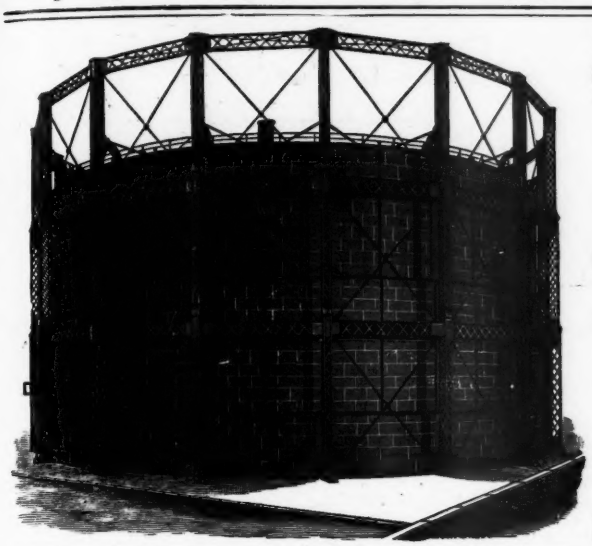
BURDETT LOOMIS, - - Hartford, Conn.

To Gas Companies.

We make to order **CAP BURNERS** to burn any amount under a stated pressure. Send for samples.

Also SERVICE CLEANERS, DRIP PUMPS, and STREET MAIN PROVING APPARATUS.

C. A. GEFRORER,
948 N. 8th St., Phila., Pa.



WILLIAM STACEY, Prest. T. H. BIRCH, Asst. Mangr.
J. E. STACEY, Vice-Prest. & Gen. Mangr. R. J. TARVIN, Sec. & Treas.

THE STACEY MANUFACTURING CO.

Established 1851.

Single, Double and Triple-Lift

GASHOLDERS,

Of any Capacity, with or without Wrought Iron or Steel Tanks.

Hydraulic Mains, Condensers, Scrubbers, Purifiers, Valves, etc.

Coal Gas Benches, Roof Frames,

OIL STORAGE TANKS.

Pressed Steel Mouthpiece Lids, Self-Sealing Mouthpiece Lids.

General Office: Cincinnati, O.
Eastern Office: 911 Drexel Building, Philadelphia, Pa.

RITER-CONLEY MFG. CO.,

GASHOLDERS, with or without Steel Tanks.

Purifiers, Condensers, Scrubbers, Oil Tanks, Smoke Stacks.

STEEL ROOFS and BUILDINGS.

PLATE AND STRUCTURAL WORK OF EVERY DESCRIPTION.

GENERAL OFFICE: Pittsburg, Pa. EASTERN OFFICE: 39-41 Cortlandt St., New York City.

WM. HENRY WHITE,

No. 32 Pine Street, - - - New York City.

ENGINEER AND CONTRACTOR FOR THE

ERECTION AND EXTENSION OF

GAS, WATER, AND ELECTRIC LIGHT WORKS.

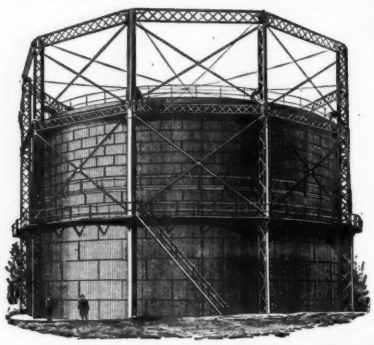
Correspondence with Gas Companies contemplating extending or improving their Plants respectfully invited.
Plans and Estimates Furnished.

1900 DIRECTORY 1900

OF AMERICAN GAS COMPANIES.

Price, - - - - - - - - - $5.00.

A. M. CALLENDER & CO., - - No. 32 Pine Street, New York.



1842 ❊ Deily & Fowler, ❊ 1900

LAUREL IRON WORKS.

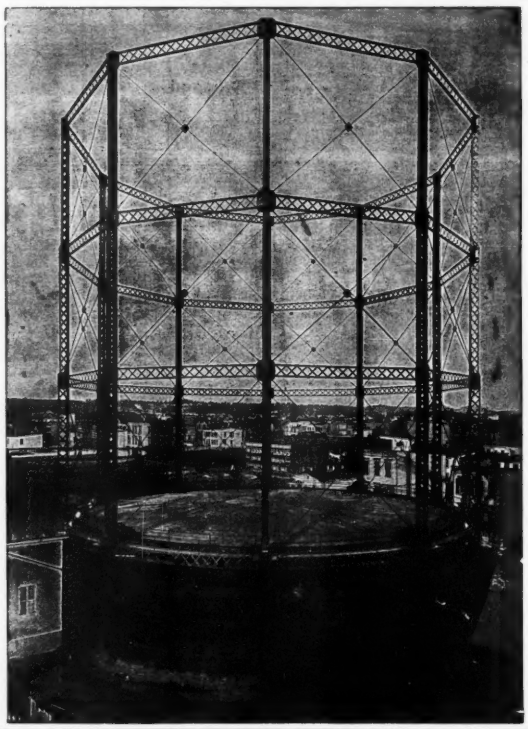
Office, No. 39 Laurel Street, Philadelphia, Pa.

BUILDERS OF

Gasholders

Single or Telescopic. With or Without Iron or Steel Tanks.

OIL TANKS, WATER TANKS, AND GENERAL WROUGHT IRON WORK.



The order for this Triple-Lift Holder and Steel Tank was received by the Logan Iron Works from the Union Gas Light Company, of East New York. The contract was completed and the Holder was in actual use in 90 days from receipt of order. Capacity of Holder, 500,000 Cu. Ft.

LOGAN IRON WORKS,

Brooklyn, N. Y.

MANUFACTURERS OF

Single or Multiple-Lift

GASHOLDERS,

Complete with Steel Tanks.

BENCHES, SCRUBBERS,
CONDENSERS,
PURIFIERS, IRON ROOFS,
Self-Sealing Retort Lids,
AND ALL PARTS OF
GAS WORKS APPARATUS.

Contractors for
Complete Works.

ALSO, SOLE MANUFACTURERS OF

C. W. BLODGET'S
HOT GAS SCRUBBER.

FIELD'S ANALYSIS

For the Year 1899.

An Analysis of the Principal Gas Undertakings in England, Scotland and Ireland. Being the Thirtieth Year of Publication.
Compiled and Arranged by

JOHN W. FIELD,

Secretary and General Manager of The Gas Light and Coke Co., London.
Price $5. For Sale by

A. M. CALLENDER & CO., - No. 32 Pine Street, N. Y. City.

Established 1854.

D. McDONALD & CO.,

MANUFACTURERS OF

WET AND DRY METERS, STATION METERS AND METER PROVERS.

ALSO MAKERS OF

THE GLOVER PREPAYMENT METER.

The amount of gas delivered for the coin can be instantly and positively changed without removing the meter or replacing any parts.

The gas registered agrees absolutely with the amount purchased by the coin.

WE HAVE MADE AND SOLD IN THE UNITED STATES

OVER 60,000 OF THESE METERS,

ALL OF WHICH ARE GIVING PERFECT SATISFACTION.

Correspondence Solicited.

561 West Forty-seventh Street, NEW YORK. | 51, 53 & 55 Lancaster Street, ALBANY, N. Y. | 34 & 36 West Monroe Street, CHICAGO.

NOW READY.

THE SIXTH (AND CENTENARY) EDITION

— OF THE —

Handbook for Gas Engineers and Managers.

By THOMAS NEWBIGGING, M. Inst. C.E.

This Edition of the "Handbook for Gas Engineers and Managers" is a great improvement on all previous editions. Much of the text has been re-written, in order to keep the work abreast of the constant advances that are being made in the Gas Industry.

PRICE, - - $6.00.

A. M. CALLENDER & CO., - - No. 32 Pine Street, N. Y. City.

PRACTICAL HANDBOOK ON

GAS ENGINES

With Instructions for Care and Working of the Same.

By G. LIECKFELD, C.E.

Translated with Permission of the author by GEO. M. RICHMOND, M.E.

Price, $1.00.

A. M. CALLENDER & CO., 32 Pine Street, New York.

NATHANIEL TUFTS METER CO.,

8 Medford Street, Boston, Mass.

MANUFACTURERS OF

DRY GAS METERS.

Station Meters of any Capacity.

Test and Experimental Meters, Pressure Registers, Pressure Gauges.

METER PROVERS, PHOTOMETERS, STREET LANTERNS, ETC., ETC.

Prepayment Gas Meters.

Established 1849. With the best facilities for manufacturing, is enabled to furnish reliable work and answer orders promptly.

CHARLES E. DICKEY. JAMES B. SMALLWOOD. CHARLES H. DICKEY.

THE MARYLAND METER AND MANUFACTURING CO.

Established 1866.

BALTIMORE, North & Saratoga Sts. **CHICAGO, 107 West Monroe St.**

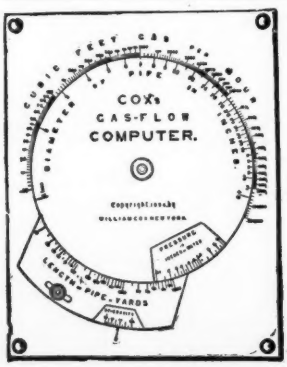
SAN FRANCISCO, 221 Front St.

CONSUMERS' & STATION METERS, PRESSURE GAUGES, Etc., Etc.

"Perfect" Gas Stoves

KEYSTONE METERS, CAREFULLY MADE.

The KEYSTONE METER CO., Royersford, Pa. and WIESTER & CO., 22 Second St., San Francisco.



Do you wish to Know

what size of Pipe to use to convey any quantity of Gas, any distance, with any loss of pressure, and any initial or final pressure? Then use

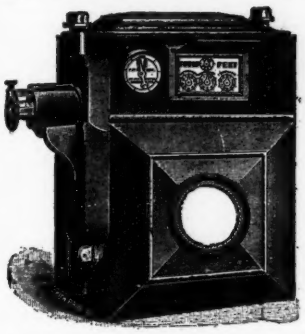
COX'S GAS FLOW COMPUTER,

as it gives this information accurately at sight, without mental effort. No calculations needed. Saves time, money and mistakes.

Price, 6.5 x 8 inches, in cloth case, $2.50.

For sale by

A. M. CALLENDER & CO., 32 Pine St., N. Y. City.



AMERICAN METER COMPANY,

NEW YORK, PHILADELPHIA, SAN FRANCISCO.

PREPAYMENT METERS.

THEIR CONSTRUCTION IS SUCH THAT THEY MAY BE READILY READJUSTED WHEN THE SCALE OF GAS RATES IS CHANGED.

HELME & McILHENNY,

Established 1848. 1339 to 1349 Cherry Street, Philadelphia, Pa.

MANUFACTURERS OF

Wet and Dry Gas Meters, Station Meters, Provers, Gauges, Etc.

METERS REPAIRED

PREPAYMENT GAS METERS.

Our Own Patents. Strong. Simple. PROMPT ATTENTION. CORRESPONDENCE SOLICITED.

METRIC METAL COMPANY,

MAKERS OF

GAS METERS for NATURAL and ARTIFICIAL GAS.

Special Attention given to Repairing METERS of all Makes.

FACTORY AT ERIE, PA.

EXCERPTS FROM DECISIONS

—OF THE—

BOARD OF GAS COMMISSIONERS of the COMMONWEALTH OF MASSACHUSETTS.

MR. E. H. YORKE, NEW HAVEN, CONN., Dec. 1, 1898.

Dear Sir:—I am in receipt of a copy of "Excerpts from the Decisions of the Board of Gas Commissioners," which is a handy compilation in book form of extracts from the most recent decisions of the Gas Commission of Massachusetts.

I note that most of these extracts are broad and safe-guiding precepts, which apply with equal force to one Company as to another. The 13 years' existence of the Board of Gas Commissioners with its unusual opportunities for acquiring information, have justly made it a high and safe authority in all matters pertaining to the management, obligations, and rights of Gas Companies. Your little book will serve as a valuable reference library in settling legal complications which often arise between a Gas Company and its customers.

Yours truly, (Signed) F. C. SHERMAN, Superintendent.

A 28-page Pamphlet containing the cream of this Board's decisions as to the proper management of Gas Companies.

Compiled by E. H. YORKE. Price $1.00. Address

A. M. CALLENDER & CO., - No. 32 Pine Street, N. Y. City.

The advertisement of

THE WESTERN GAS CONSTRUCTION COMPANY, Engineers and Builders,

Improved Double Superheater Lowe Water Gas Apparatus—Manufacturers of General Gas Works Machinery—Builders of Gas Works

WM HENRY WHITE, Eastern Engineer, 32 Pine St., New York.

FORT WAYNE, IND.,

Occupies this space every alternate week.

JOHN J. GRIFFIN & CO.,

1513-1515-1517-1519-1521 Race Street, Philadelphia.

52 Dey Street, New York. WM. S. GRIBBEL, Manager.

75 N. Clinton St., Chicago. FREDERICK WAUGH, Manager.

MANUFACTURERS OF

STATION METERS, CONSUMERS' METERS,

Provers, Registers, Gauges, Experimental Apparatus, Etc.

Prompt Attention Given to All Repairing.

OUR SPECIAL NATURAL GAS METER

Is the Best ever offered. Over 30,000 now in use.

We manufacture in the United States, under the **SAWER & PURVES PATENTS**, the

Positive Prepayment Meter.

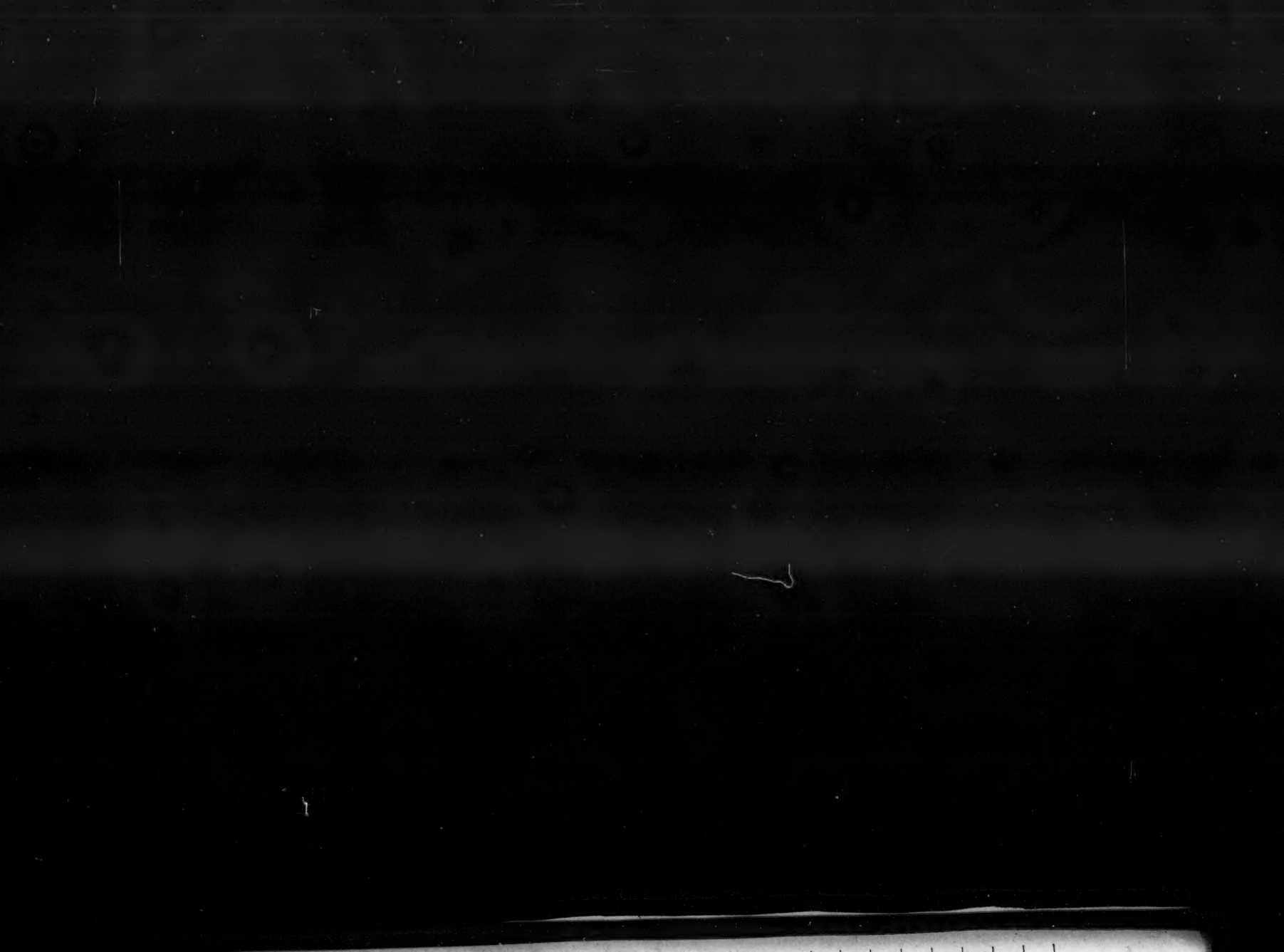
. . SIMPLE . .

. DURABLE .

. ACCURATE .

. RELIABLE .

All Parts Interchangeable

This Meter is an unqualified success in Great Britain. Its simplicity of construction, and the positive character of the service performed by it, have given it pre-eminence.

Needs Only the Care Given an Ordinary Meter.
Saves MONEY, TIME and CONSUMERS.
Dispenses with "DEPOSITS" and Increases OUTPUT.